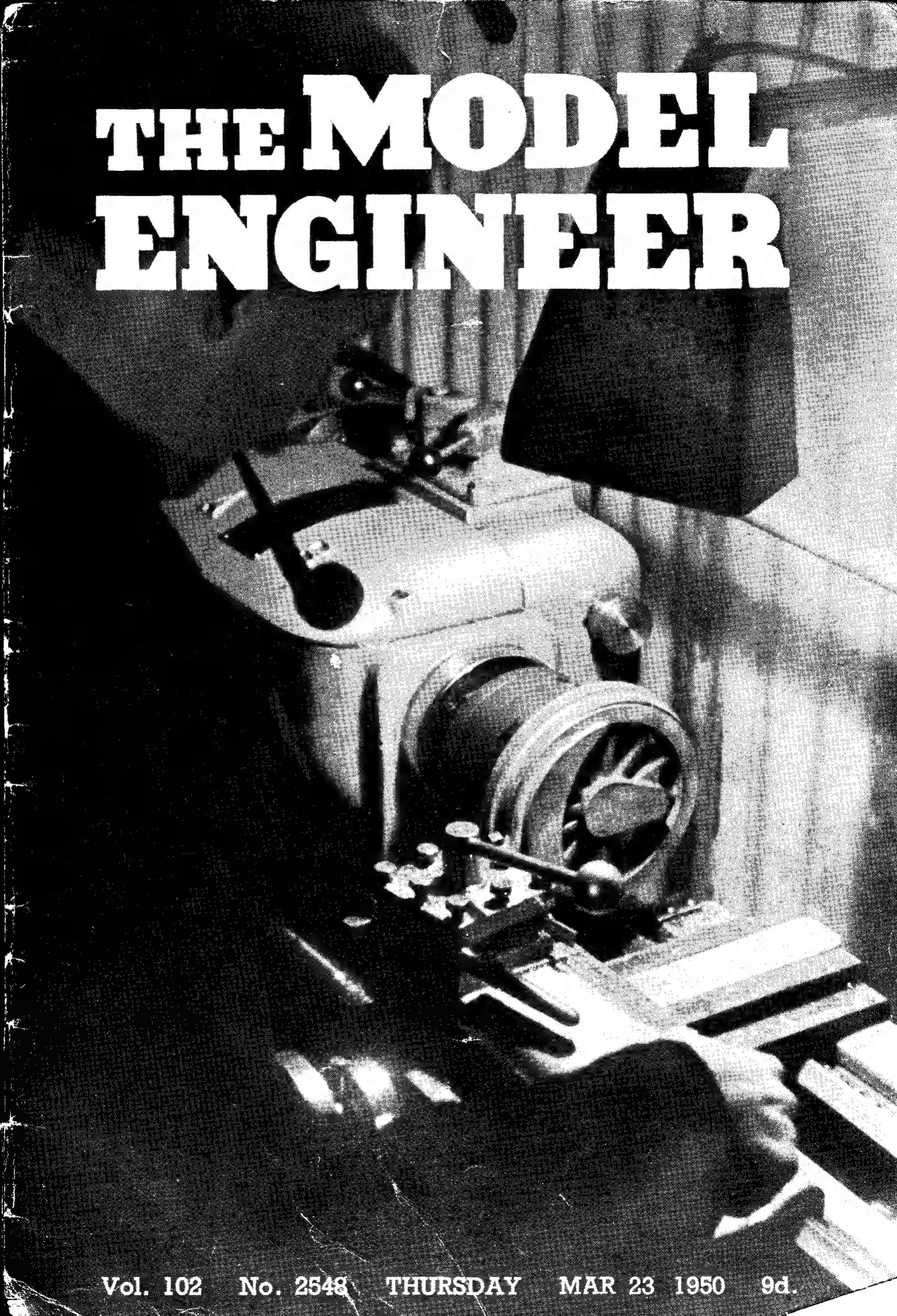
# THE MODEL ENGINEER



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# The MODEL ENGINEER

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23RD MARCH, 1950 VOL. 102 NO. 2548



## SMOKE RINGS

### Our Cover Picture

● THIS PHOTOGRAPH, submitted to us by Mr. P. S. Lamb, of Stratford-on-Avon, depicts a typical subject in the model engineering workshop, namely, the machining of wheels for a model locomotive. The projected locomotive is to be a $7\frac{1}{4}$-in. gauge 0-4-0 tank of extremely simple construction, in order to facilitate completion in the minimum time. The reason for the 0-4-0, with its short wheelbase, is that it is required to negotiate sharp curves. It is intended to have Baker valve-gear, operating piston valves. Up to the present, construction has not progressed beyond the frames, beams, driving wheels and buffers. All the motion work is to be fabricated by Sifbronzing to save hacking out from the solid. Mr. Lamb's other modelmaking activities include constructing the "*Maid of all sorts*," described by "L.B.S.C." at the end of 1948, and a good deal of original construction, or reconstruction, of traction engines, $3\frac{1}{2}$-in. gauge locomotives, a complete ship's engine-room, and before the war, he constructed several models of Messrs. Priestman Bros'. grabs. The lathe shown in the photograph is one made by Messrs. Harrison, of Heckmondwike, and is fitted with a home-made 4-tool turret, the slots of which were machined with a $\frac{3}{8}$-in. end-mill. For the benefit of readers interested in photography, the photograph was taken by Mr. D. A. Jones, of Reading, with a Leica camera, the exposure being 1/60th of a second at f/3.5 using H.P.3 film. Illumination was by a single photoflood bulb used in the lampholder normally employed for illuminating the lathe.

### Traction Engine Drawings and Castings

● IN A note published in our issue for February 9th, we referred to the fact that detailed drawings and castings for large-scale traction engine models are, at present, rare and we mentioned only two lots that we could recall. Messrs. Bassett-Lowke have reminded us that they have recently placed on the market drawings and a set of castings for a $1\frac{1}{2}$-in. scale Burrell traction engine. The drawings for this were prepared by Mr. Bretherton, of Oxford, who was for many years associated with the designing of the prototypes; therefore, readers may confidently assume that the model is entirely authentic.

## Nottingham Society Attains Majority

● AN INTERESTING and friendly letter from Mr. A. J. Witty, vice-President of the Nottingham Society of Model Engineers, informs us that the society attained its majority early in February. It was on February 7th, 1929, that the "proverbial 13" members met at a local "pub" and successfully launched a society which rapidly progressed to be one of the largest provincial societies. Although the early efforts suffered a calamity when, following the first exhibition, the secretary absconded with all the proceeds and funds, leaving the society indebted to the local hospital to whom the proceeds had been promised, the members met their obligation worthily by means of a "whip round."

Mr. Witty's letter goes on: "A founder-member myself, I look back with much pride on our past achievements, but do not forget our indebtedness to several of the fraternity for the kindly assistance so readily forthcoming in the days of our need of outside support. The late Percival Marshall honoured us by opening one of our early exhibitions; and on other occasions, we have had Mr. Maskelyne, the Rt. Hon. the Earl of Northesk and 'Uncle Jim.' The last-named was always with us at exhibition times, providing the major attraction, the ever-popular passenger-carrying railway. Mr. Fred Smith, of Pinxton, also one of our founder-members, did much to further the movement, and still makes time to run the Pinxton Society and give us continued support.

"Naturally, after 21 years, a number of our early members are not now with us; however, those whose callings have taken them afield, still keep in touch, and as our annual exhibitions come round, acquaintances are renewed and reminiscences of the early struggles are the topic of conversation.

"1950 brings us to our 14th exhibition, which will be held at the Victoria Baths, Nottingham, for four days, March 29th to April 1st, inclusive; each has been larger than the previous one, until we have come to occupy the largest hall available in the city."

We congratulate the society at this momentous time; we hope that the proud record will be well maintained at the forthcoming exhibition, and we offer our sincerest good wishes for continued success and prosperity.

## The Kodak Exhibition

● DATES TO be noted in the diaries of many readers, and especially of members of the S.M.E.E. Affiliation, are Saturday and Sunday, April 1st and 2nd next; for on those days the Kodak Society of Experimental Engineers and Craftsmen will be holding its annual exhibition of models, arts and crafts. The venue will be Kodak Hall, Wealdstone, as usual, and the exhibits will be divided into no fewer than 14 separate classes. These will include, respectively: Locomotives; marine engines; boilers, boiler fittings and mountings; general mechanical models; tools and workshop appliances; clocks; scientific instruments, optical apparatus, etc.; electric models and equipment; working drawings; miniature locomotives and railway equipment; aero models; arts and handicrafts; ladies' section; work by students of Kodak Training Centre; and, finally, youth organisations. These are the main headings; some of them are sub-divided into four or five sections. It is obvious, therefore, that the exhibition has been planned on the most comprehensive lines within its scope, and is now one of the most important events in the model engineer's calendar.

## The Brighouse Society's Forthcoming Exhibition

● MR. N. ALLEN, hon. secretary of the Brighouse Society of Model and Experimental Engineers, has written to let us know that the society will be holding a Model Exhibition in the Drill Hall, Prescott Street, Halifax, from June 6th to the 10th, 1950, inclusive. An excellent show is expected, with a good selection of models, and valuable prizes are being offered in the competition classes, with the addition of a special award for the best model in the whole exhibition.

We are interested to know that the hall is a large one measuring some 115 ft. by 55 ft., so there should be ample space not only to ensure that the exhibits will be displayed to the best advantage, but also that the visitors will be able to examine them in comfort. Mr. Allen, we are sure, will be glad to give any further information that may be required; his address is: 3, James Street, Brighouse, Yorks.

## Apologium

● WE REGRET that through an inadvertent misunderstanding, the lower illustration on page 297 of THE MODEL ENGINEER for September 1st, last, was published without any acknowledgement. We have been informed that the original photograph is the copyright of Mr. J. P. Mullett, of Northchurch Common, Berkhamsted, Herts, to whom we apologise for any annoyance he has been caused.

## Obituary

● WE LEARN with deep regret of the passing of an old friend and craftsman, Arden W. Marchant. Although quite unconnected with engineering in his business, his knowledge, experience and practical achievement in the model engineering world are, probably, unsurpassed. A regular exhibitor at THE MODEL ENGINEER Exhibition before the war, and championship award winner in 1938 with an exquisite marine engine, his work will long be remembered and appreciated. This particular winning model was offered to and accepted by the Science Museum, where it now provides an everlasting tribute to the masterly expression of this craftsman. We remember the late Mr. Percival Marshall saying of our friend, A. W. Marchant: "I know of only one other person, Dr. Bradbury Winter, who so completely captures the atmosphere of the original in all his work."

This charming personality will long be remembered.

# A MODEL OF A MODELS EXHIBITION

THE writer recently undertook the self-imposed task of building this Diorama model for the second Northern Models Exhibition, which opens at the Corn Exchange, Manchester, on March 24th. He has found this a pleasant change from small locomotives and the like ; an opportunity to apply decorative treatment and to make a useful entry for the show. Modellers who have seen the wonderful professionally-made miniature of Mulberry Harbour, which toured the country some years ago, will not need to be reminded of the scope for artistry and workmanship in many materials which a construction of this kind provides.

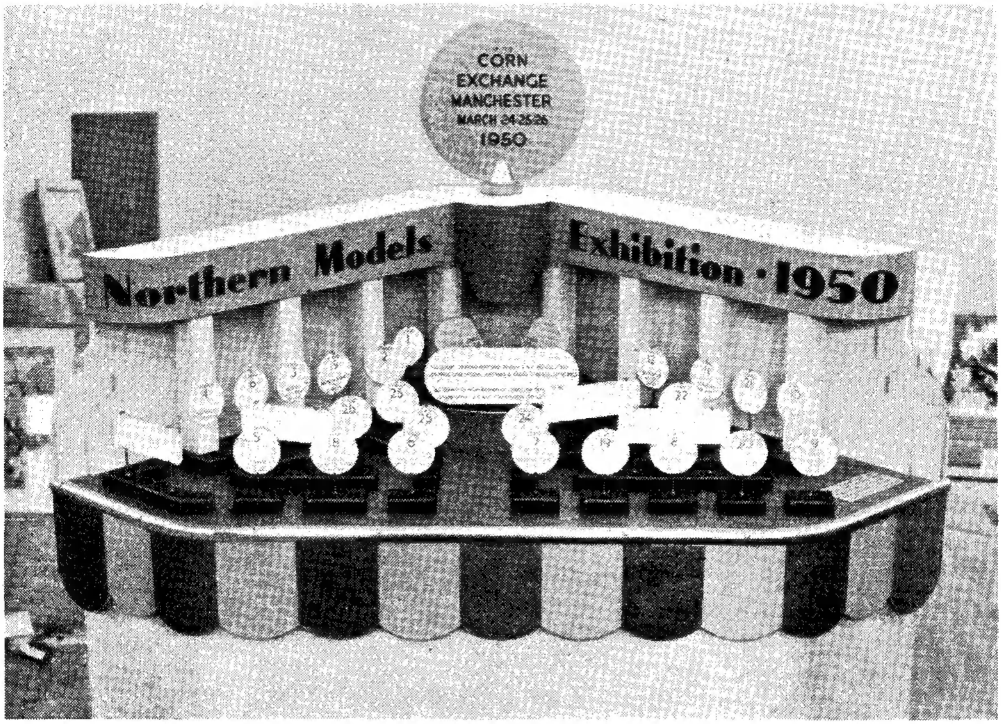



*Photo by*] [*Kemsley Studios*

The first attempt in this manner by the writer, was a toy-model for his son, then five years old, who spent many happy hours opening and closing the two bridges—one a swing aqueduct—of this simple representation of Barton Bridges on the Manchester Ship Canal.

A waterline " three island " steamer completed the illusion, a " must " job, produced in Herr Claus's factory in a fortnight.

Wood, cardboard and brickpaper were the materials used, the background being a painted scene of Barton Power Station with the Bridgewater Canal and road wending their way round it.

Again, in this model, use has been made of paper of various colours—gold, silver and azure blue—to fit the colour scheme completed with peach flat oil paint and black enamel.

This time, the scenic model is not intended as a toy, but as a consultant, a guide to the show and an attempt to ease the work of the stewards. Commenced in June, 1949, the finishing date was advanced six weeks when an opportunity was presented to put the model in another Arts and Crafts Show at the writer's place of employment. This entailed something of a gallop in the last stages, many details had to be simplified to complete the job in time.

In this connection, the use of " Uno " pen stencils for lettering the multitude of circular descriptive panels on the stands was a great advantage, and saved hours of time over the brush method.

The difficulty of storing the model was not fully realised when construction began, and in the near future aluminium legs will be made to take the place of the bulky lower pedestal.

Now that pulp building-boards and hard boards are available without restriction, why not begin something soon for completion in 1951 ? your model of a typical scene of British life may find itself an exhibit in the Festival of Britain in that year. With this as a goal the domestic authorities may even allow some of the artistic bits to be made in a comfortable place by the fire !

—R. E. PRIESTLEY.

# "L.B.S.C.'s" Beginners' Corner

## Walschaerts Valve-Gear for "Tich"

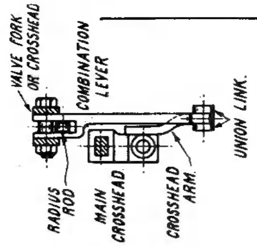
BEFORE going into details of the Walschaerts gear for our weeny four-wheeler, maybe it would be as well if I explained to our beginner friends, the how and why of it. Most folk can do a job better, if they know exactly what they are doing; though you would be surprised at the number of good folk who have made up one of my engines "in blind faith," had the shock of their lives when it ran all right at first time of steaming, and then proceeded to find out *why* it did, after the excitement had died down. Well, this is how it happened. Egide Walschaerts was a Belgian locomotive foreman, and it appears that (like many of his confrères in early days in this country) he was nearly driven daft by the antics of some of the weird and wonderful valve-gear arrangements fitted to the locomotives in his charge. Old Abner Baker had the same sort of experience in U.S.A., only in his case it was traction engines. Anyway, friend Egide thought it was high time somebody had a shot at designing a valve-gear that wouldn't give trouble; so, believing in the old saying that if you want a job done properly, the best thing is to do it yourself, he set to work on the problem. Naturally, on a job of that kind, it was a case of trial and error; and our Belgian friend didn't get it right first time, by long chalks. He produced and tried out several different forms of valve gears, just like old man Abner mentioned above, when he was bitten by the same kind of insect; but in due course they both hit the bull's-eye, Abner with the Baker gear and Egide with the Walschaerts. Incidentally, this was another case of history repeating itself, for the Belgian did his job very many years before the American.

It would take too much space here, to describe how the Walschaerts gear, as we know it today, was "evoluted" from Egide's first design, so I will just describe it as he finally perfected it. He aimed at producing a valve-gear in which each part did one job, and one job only; different from cases where one part had to perform two or more functions, and hashed up half of them. The gear is divided into two distinct parts; the part determining the direction in which the engine travels, and the part which attends to the lap-and-lead movement of the valve. If you take a stick of wood, drive a nail through the middle, and loosely attach it to the garden fence, for example, you can see in an instant how the reversing part works. If you waggle the bottom of the stick from side to side, the top part waggles an equal amount, *but in the opposite direction.* Suppose the bottom end is worked from a fixed eccentric on the driving axle of an engine, and you have another rod, connected to the slide-valve, which you can attach either to the top or bottom of the stick. If you connect it to the bottom of the stick, the valve-rod would move in unison with the eccentric, and the engine would go, say, forward. If you connect the valve-rod to the upper end of the stick, it goes exactly the opposite way to the eccentric, and the engine would go backward. Substitute a slotted link for the stick; connect the valve-rod to a die-block sliding in the slot, so that it can readily be moved from one end to the other; replace the eccentric by a return crank set at right-angles to the main crank, and you have one of the fundamental parts of a Walschaerts gear.

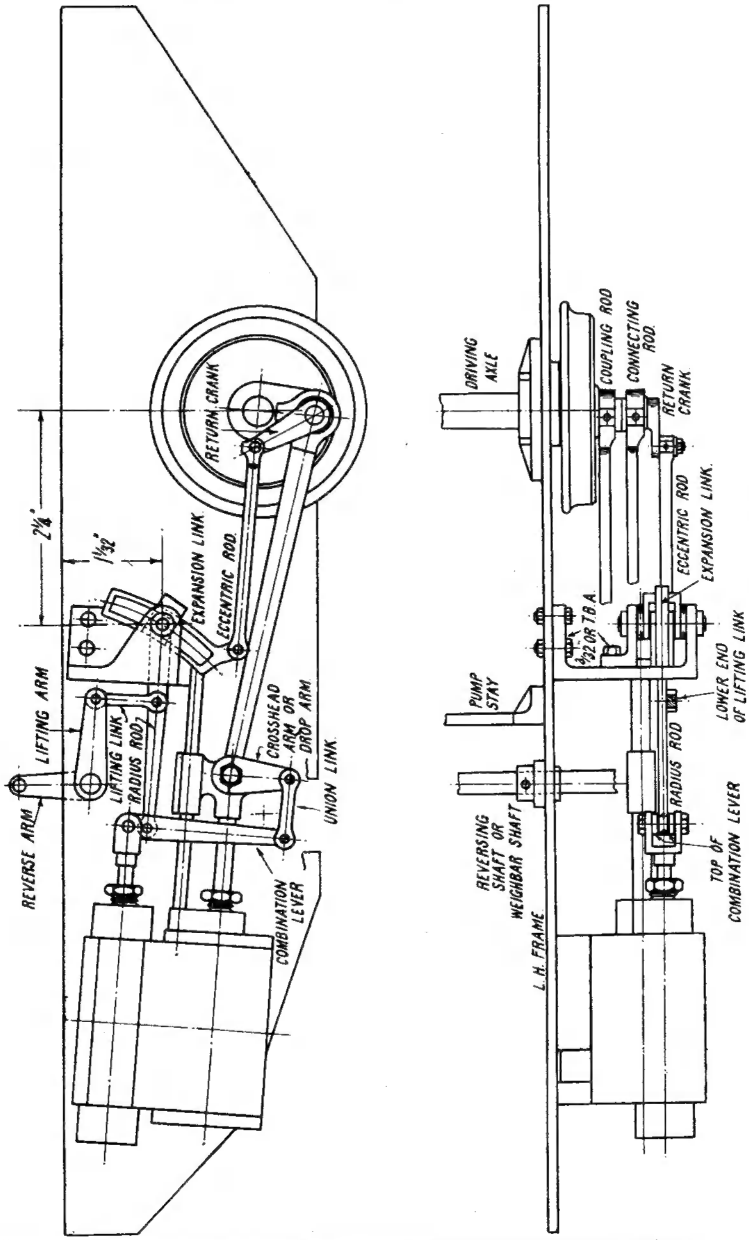
### Lap-and-lead Movement

If the valve is exactly the same length as the distance between the outside edges of the steam ports, and thus has no lap, the simple arrangement described above would be all that was needed; but the valve has to be moved over a greater distance, so that the lap at each end starts to uncover the port at the instant the crank reaches the dead centre. This is easily done by a simple connection from the main crosshead. We won't bother about inside-admission piston valves for the time being, but merely concern ourselves with the simple slide valves as fitted to *Tich.* Now instead of the rod which connects the die-block with the valve (called the radius rod) going direct to the valve-spindle, it is connected to the top of a hanging lever, which itself is connected to the end of the valve-spindle a short distance above. The lower end of the hanging lever (called the combination lever) is connected to the crosshead by a drop-arm and a short link (called the union link) which arrangement is clearly shown in the accompanying illustrations.

Now take a look at the elevation of the gear. When the die-block is dead in the middle of the expansion link, as shown, it is obvious that however much the link is waggled back and forth, the die-block—and consequently the radius-rod attached to it—will not move, for the simple reason that the block is in line with the pivots, or trunnions, on which the link oscillates. Therefore the point at which the other end of the radius-rod is attached to the combination lever is also a temporary fixture. Now, if the wheels are turned so that the crosshead is right up against the cylinder cover, the union-link, will push the bottom of the combination lever forward (toward the cylinder); and the radius-rod connection not being able to move, for the reason stated above, the combination lever will turn on it, and the upper part will move away from the cylinder, taking the valve spindle with it, and thus moving the valve sufficient to start opening the front port. Conversely, when the crosshead is as far away from the cylinder as possible (back dead centre) the combination lever will be tilted in the opposite direction, and the top of it will move far enough toward the cylinder, to push in the valve spindle far enough to allow




*Lap-and-lead movement, showing clearances*




*Elevation and plan of Walschaerts valve-gear to " Tich "*

the valve to " crack " the back port. Therefore, with the die-block in the middle of the link, the ports " crack " on each dead centre at every turn of the wheels.

### The Combined Movement Does the Trick

We have already learned, from studying the loose-eccentric valve-gear, that for correct timing, the " crack " of the port must take place on each dead centre. Now, if we put the Walschaerts-gear engine's crank on dead centre, and take a look at the link, we find it is exactly vertical, and the die-block can be shifted from top to bottom of the link without moving the valve spindle. We have also seen, that with the crosshead at either extreme—that is, when the crank is on front or back dead centre—that the combination lever is in the position to " crack " the port. We now see that with the Walschaerts gear, it doesn't matter a bean what position the die-block occupies in the link—top, bottom, or any place in between—the ports will " crack " on each dead centre when the link arrives at the vertical position ; and as the amount of the crack constitutes the " lead opening," to give it the correct title, the lead will be constant for full forward gear, full back gear, or any notched-up position of the gear. The action of the drop-arm, union link and combination lever is just to make sure that the valve starts to open the port at each dead centre, *and nothing else.*

The rest of the port opening is done by the oscillation of the link. Naturally, if the die-block is at the end of the slot, it will move farther, and give a greater port opening, than when it is near the middle. Also, if it is at the bottom of the link, it will move in unison with the return crank, and cause the engine to move in one direction. If it is at the top—or, in fact, any place above the link bearings—it will move in the opposite direction, and so reverse the direction of movement of the engine. Either movement, of course, is transmitted to the valve by the radius-rod, the top of the combination lever, and the valve spindle. We thus see that the link, die-block, and radius-rod control the amount of port opening, and the direction of movement ; and the drop-arm, union-link and combination lever advance the valve to the " lead " position at each dead centre, irrespective of the direction of movement, or the amount of port opening. The two movements, acting together, give the correct valve events.

There is one more desirable feature about the Walschaerts gear, and that is the quick release of the exhaust steam. The sudden reversal of the valve as the combination lever " does its stuff " just before the end of the stroke, causes the edge of the exhaust cavity in the valve, to uncover the inner edge of the steam port all-of-a-sudden-Peggy, and away goes the spent steam, up the blastpipe and out of the chimney, with great alacrity. No " go-slow " movement there ! This is the reason why a *King* or *Castle*, pulling a heavy load out of Paddington, tries to blow the chimney off the smokebox, and dislodge the girders of Bishop's Road bridge. My own little engines perform exactly the same antic ; none of the feeble " chiss-chiss " that we used to hear before the advent of the " real live steamers " ! It isn't so much the *amount* of steam which produces the bark, but the speed at which it leaves the blast nozzle. The old small-port-no-lead-straight-slide engines had a loud puff, but it was " dead as ditchwater " in a manner of speaking ; the engines sounded as if they were choking themselves, as indeed they were !

Bearing in mind the above explanation, the rawest recruit can take a look at the drawings of the Walschaerts valve-gear for *Tich* and should understand them perfectly. You'll see that the expansion link is carried by a bracket bolted to the frames, and the bracket also supports the outer end of the guide-bar. A return crank, or " eccentric crank " as it is known in U.S.A. and Canada, is fixed to the main crank, and connected to the link tail by an eccentric-rod, thus performing the waggling act. The wide-jawed fork or crosshead on the valve-spindle carries the slotted head of the combination lever, the bottom of which is operated by the connection to the main crosshead. One end of the radius-rod is pinned to the combination lever in the slot ; the other end carries a die-block working in the link slot. The die-block is lifted and lowered, and held in any position in the link slot, by a small drop-link actuated by an arm on the reverse shaft. This shaft carries a vertical arm at the right-hand end, which is connected to a hand lever in the cab, by a straight rod called the reverse-rod, or reach-rod.

If the lever in the cab is pushed forward, the reverse arm will also move forward, and the lifting arm will move up, lifting the die-block to the top of the slot in the expansion-link ; so if we want the engine to run the same way as the inclination of the lever, we must arrange for the upper half of the link to be set for forward motion, and the lower half for backing. This is easily done. If you remember, the loose-eccentric gear drove through a rocking shaft with directly-opposed levers ; and when the engine was going ahead, the eccentric (driven by the stop collar) was following the crank. The expansion-link, being pivoted in the centre, will act exactly in the same way as the rocker, when the die-block is at the top. As the eccentric-rod is connected to the lower end, all we have to do is to set the return crank in the same relationship to it, as the loose-eccentric is to the rocking shaft in forward motion ; that is, following. Look at the elevation of the Walschaerts gear, and you will see, whatever the position of the main crankpin, the return crankpin is a quarter-turn behind it. When one speaks of an eccentric or return crank as " leading " or " following," this always refers to its position in forward gear ; easy enough to remember !

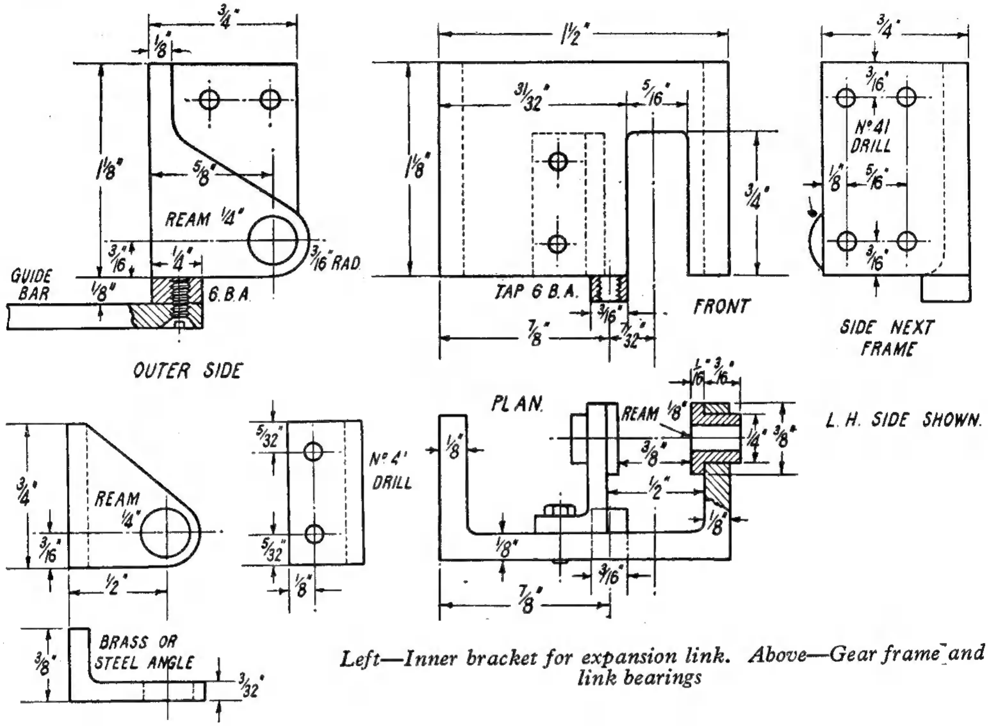
The above explanation of the " whys and wherefores " may not be very " scientific " ; anyway, it isn't intended to be, but I fancy it will convey more to the average beginner than the " learned treatise " type of description. So much for that ; let's get busy, and see if we can put what we have learned to practical use.

### Link-brackets for Walschaerts Gear

The above is about the best thing for the beginner to start on. The brackets can be made

up from castings, or built up from plate material ; don't forget you will need one right-hand, and one left-hand. The left-hand one is shown in the illustrations. If a casting is used, smooth off the broad face of it with a file ; then, to true it up, lay a sheet of fairly coarse emery-cloth or other abrasive, on something flat, and rub the face on it, same as truing port faces. The sides must be at right-angles to the front ; if a milling machine is available, it is a simple job to clamp the casting in the machine-vice on the miller table, set it truly with a square, and take off the surplus metal from each side, with a small slabbing cutter on the arbor of the machine. If not, use the lathe again, milling off each side of the casting in the same manner described for the pump-stay. Alternatively, the humble necessary file will do the trick, if carefully handled. Test with a try-square, putting the stock against the wide face of the casting, and the inner side of the blade against each side in turn. You'll soon see if any wants to come off, and exactly where to file, if you hold it up to the light and look between blade and casting. The little boss at the bottom, for attachment of guide-bar, should also have its contact surface at right-angles to the front of the casting.

A piece of brass or steel channel, 1½ in. wide, with ⅞ in. sides, and ⅛ in. thick, would make a fine bracket that needed no machining. Maybe our advertisers supplying *Tich* material, would do the needful. This would merely need sawing and filing to the shape and size shown in the illustrations, and drilling for the bolts and bushes. A little block of brass or steel, as the case may be, ¼ in. long, 3/16 in. wide, and ⅛ in. thick, would have to be silver-soldered on, for attachment of the guide-bar at the position shown in the drawings. The slot for the radius-rod should be cut out in the same way as the openings for the hornblocks were cut in the main frames. The bracket could also be made from a piece of ⅛-in. plate, 1½ in. long and 1⅛ in. wide, slotted as shown, with a piece 1⅛ in. by ¾ in. by ⅛ in. thick, at one side, and another piece, shaped and drilled as shown at the other side, both pieces being brazed on if steel, or silver-soldered if brass. Whether the bracket is cast, made of channel, or built up, the hole for the link trunnion bush must go through dead square ; so very carefully mark it off, centre-pop, and drill first with a ⅛-in. drill, either on a machine, or else in the lathe, with the drill in three-jaw, and the bracket held against a drilling-pad, or the end of the tailstock barrel, with centre removed. Open out to 15/64 in. or with letter " C " drill, but don't ream yet.




*Left—Inner bracket for expansion link. Above—Gear frame and link bearings*

The small bracket carrying the inner link trunnion is made from a piece of ¾-in. by ⅜-in. by 3/32-in. brass or steel angle. If the unequal angles are not available, use ¾ in., and saw away the unwanted part. Cut off a piece a full ¾ in. long, file to shape, drill the screw-holes, and for the link trunnion bush, drill a ⅛-in. hole, opening out to 15/64 in. or letter " C " as above. Clamp this bracket temporarily in position on the larger one, ½ in. from the outer side, as shown in dotted lines on the drawing showing the front

of the bracket, and more clearly in the plan view; a toolmaker's cramp will do the needful, but before tightening it, put the shank end of the drill through both the holes for bushes, to line them up. The drill should fit easily enough to turn with finger and thumb; if it goes stiff, the holes are not truly in line. Put the No. 41 drill through the two screw-holes, and make countersinks on the large bracket; follow up with No. 48, going right through, tap 3/32 in. or 7 B.A., and put a couple of screws in, hexagon-headed for preference. Finally, put a $\frac{1}{8}$-in. parallel reamer through both the bush holes at once, which naturally ensures that they will both be dead in line.

These two holes are bushed to take the link trunnions. Chuck a bit of good hard $\frac{3}{8}$-in. round bronze rod in the three-jaw; face the end, centre, and drill down about $\frac{5}{16}$ in. depth with No. 34 drill. Turn down $\frac{3}{16}$ in. of the outside, to a press fit in the reamed holes in the bracket, recollecting your previous experience of turning press fits for crankpins and wheel seats. Part off at a little over $\frac{1}{16}$ in. from the shoulder, and repeat process, making all four whilst at the job. Reverse in chuck, and face off each head to a bare $\frac{1}{16}$ in. width; then press into place. Note which side the heads go; see plan view. Take off the small bracket to do this job, and replace when both bushes are pressed home. Replace the small bracket, and put the screws in tightly; then put a $\frac{1}{8}$-in. parallel reamer through both bushes together, thus ensuring that they will be in line, and the link will be able to swing back and forth perfectly easy, but without any shake. Much of the bad valve setting, and syncopated exhaust beats, found on club and other tracks, is due to the expansion-links being sloppy in their bearings.

### How to Erect the Brackets

This job is easy enough; it only requires a little care. Take another look at the plan and elevation drawings, and you will see that the little block underneath the bracket, is right at the end of the guide-bar. Set your bracket on it thus; but have the crank on back dead centre, with the piston-rod fully extended, and the crosshead as near to the end of the guide-bar as possible. That will ensure that the bar is itself in correct position, and not forced down, or to one side, by the bracket, whilst same is being fitted. Put a toolmaker's cramp over the side of bracket, and the frame, and screw up tightly. Turn the wheels by hand, and make sure the crosshead is free to slide its full movement along the guide-bar.

Now carefully check the position of the link trunnion hole in the bracket. The centre of this should be $2\frac{1}{4}$ in. ahead of the centre-line of the driving axle, and 1 1/32 in. from the top of the frame. If you have followed the "words and music" correctly thus far, the measurements will be as given. If it is slightly out, there isn't any cause for alarm and despondency. A thirty-second or so above or below the vertical measurement, won't affect the working of the engine to any appreciable extent. Any slight variation in the distance from the vertical centre-line of the driving axle, can be put right by adjusting the position of the bracket; as long as the little block supporting the guide-bar, doesn't foul the crosshead at the end of the stroke, its exact position on the bar doesn't matter, within reason. Tighten the cramp, and run the No. 41 drill through the frame, using the holes in the bracket as guides. The top two are plain sailing; the bottom one opposite the bushes, can be got at by poking the drill through the bushes; but the other one is obstructed by the outer side of the bracket, so you'll have to put a bent scriber through the hole, make a little circle on the frame, remove the bracket, centre-pop the middle of the circle, and drill the hole. That is, of course, unless you get up to one of your humble servant's wangles! For making countersinks through holes where an ordinary straight drill won't reach, I use a broken bit of drill soldered into a short length of steel spring, into the other end of which is fixed a short length of silver-steel, about the same size as the drill. This is held in the chuck of a Millers Falls hand-brace. The point of the drill is inserted in the guide hole, and the bit of spring acts the same way as a flexible shaft, allowing the drill to turn, although out of line with the chuck. Naturally, you can't put much pressure on the drill, but it answers O.K. for jobs such as mentioned above.

After drilling all the holes and filing off any burrs around the edges, fix the bracket temporarily in place with a couple of little bolts, 3/32 in. or 7 B.A.; no need to put the lot in yet, as the bracket has to come off again when erecting the gear. The bolts can be made by using pieces of 3/32-in. silver-steel with a nut on each end. Then mark off the position of the hole in the guide-bar, on the little block under the bracket, as described for the bracket used with loose-eccentric gear; drill No. 44 and tap 6 B.A., and attach the guide-bar with a countersunk screw.

Now we are all set to make the various components of the Walschaerts gear.

## For the Bookshelf

**The London Motor-Bus, 1896-1949,** by R.W. Kidner. (South Godstone, Surrey: The Oakwood Press.) 44 pages, size 5 in. by 7 in. Price 4s. 6d. net.

This is a nicely printed and very fully illustrated pocket history of the London motor-bus, tracing its story from the purely experimental stages in the late 1890's right up to the present time.

The illustrations will certainly revive memories for older readers and provide interest mingled, perhaps, with some amusement for the younger generation. The text is well written and clearly brings out the part played by the 130-odd separate concerns which have helped to build up the vast organisation of public transport which is taken for granted now by London's millions of daily travellers. Due tribute is paid to the courage, determination and forethought of the early concerns which pioneered the great project.

# *Tin Bashing*

*by J. Gascoigne*

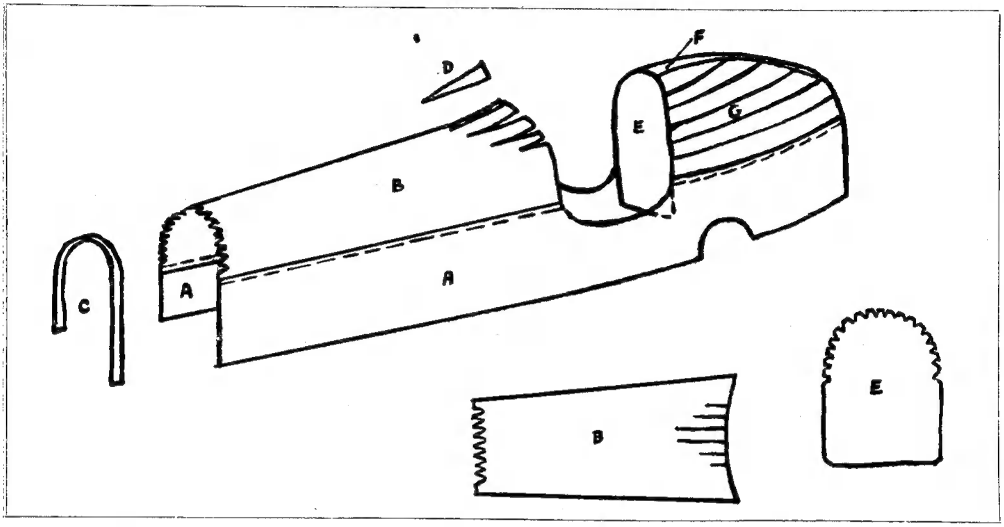
THE " art " of tin bashing does not need to come into the making of a model car body. Only the most elementary knowledge of forming metal is necessary, and filler and paint will do the rest.

There are two methods open to the constructor, both of which necessitate making the body in sections and soldering together and probably both will be combined to form one body. One method is to cut notches in the parts to make rough bending to shape possible ; the other, " plating " of the work by making suitable sections and soldering together.

Tinplate can be obtained at ironmongers and metal warehouses. About 30-gauge (12 thou.) material is required. Although this will appear very flimsy in the sheet it will build up into a rigid body ultimately. Soldering the material is very simple ; no cleaning is necessary generally, although occasionally a cut edge that has been left will need a file put across it to clean it up. " Fluxite " or similar flux is suitable and is easier to apply in paste form.

The sketches explain the general construction of a simple-type body. Builders of other types will have to scheme out their own " build-up " method. As will be seen, two side members (*a*) run right through either side and apart from being sprung round to shape, do not require any working. They will need to be temporarily fixed to the chassis or to a wood base of similar plan shape. Any notching for axles, jet-needle spindles, etc., should be done before fitting up. Notchings that cannot be made with tinman's snips can easily be made by using a narrow chisel about $\frac{1}{8}$ in. wide and hammering on to a flat piece of steel or cast-iron. If the contour of the notch is followed continuously, the piece can easily be broken out. A light dressing with a flat hammer will flatten any roughness without stretching the metal out of flat. A tip for flattening plates is to put them on your flat piece of steel and rub the edges lengthways with tne flat of the hammer head, keeping up a good pressure—in other words " ironing " it flat.

Now for the bonnet, radiator and scuttle (which can be in one or more sections) (*b*). Bend a suitably-sized piece of tinplate over a roller or piece of tube of only about three-quarter the diameter of the finished job. It will spring out after folding round the roller, hence the lesser diameter. Fit this in position and scribe the overlapping side edges. Now trim the edges back to allow an even $\frac{3}{16}$ in. or $\frac{1}{4}$ in. overlap. Rough trim radiator and scuttle ends. Refit in position and solder to side members.




Notching for the radiator is done next. Depending on the boldness of the radiator curves the notches are cut as shown. The closer together the better the shape, although one must bear in mind that the gaps must be wide enough to allow for the reduction in size of the radiator opening when they are bent inwards. A former (*c*) will be required, made from tinplate and bent to correct shape. Two or three tongues can be bent inwards with small pliers and the former soldered to these. Check this former for position before bending and soldering the rest of the tongues to it.

Where outward curves are required the procedure is slightly different. Notches are not necessary, only cuts. When bent, a vee-shaped gap will appear. Fit a former, cut and bend to correct shape, and solder in position. The gaps can now be filled with suitably-sized gusset pieces (allowing $\frac{1}{8}$ in. laps) and soldered on to the inside (*d*).

The tail end will have to be treated somewhat differently, as a different type of curving is required. Cut [redacted] seat back [redacted] shown, allowing for the overlaps and notching as shown at (*e*). These latter can be bent at right-angles with [redacted] wide-nosed pair of pliers and when done this item should be soldered to the side members [redacted] its correct position.

Centrally from the seat back a strip (*f*) should be fitted formed to the correct elevation-curve and approximately to the cross-section curves. This piece may run right down to the bottom of the body or may be in two pieces—the lower section joining the two side members at the extreme tail. A word on bending this and the other plates that will form the remainder of the tail. These strips of tinplate can be worked surprisingly easily by hammering with [redacted] small ball-ended hammer using [redacted] piece of lead as an anvil. Either lead cast into [redacted] block about 3 in. × [redacted] in. × $\frac{1}{2}$ in. or more thick, or sheet lead doubled up and hammered flat, are suitable. Hammer the workpiece on to the same spot on the lead block all the time and this and the work will soon begin to hollow out to [redacted] curve. Keep passing the workpiece over the block to form it [redacted] little at [redacted] time throughout its length. Beware of getting too much curve [redacted] it is much more difficult to reduce the curves than to increase them. Test-fit the piece to the body from time to time to obviate this. A few minutes' experimenting with [redacted] spare piece of tin will soon give the idea of the operation.

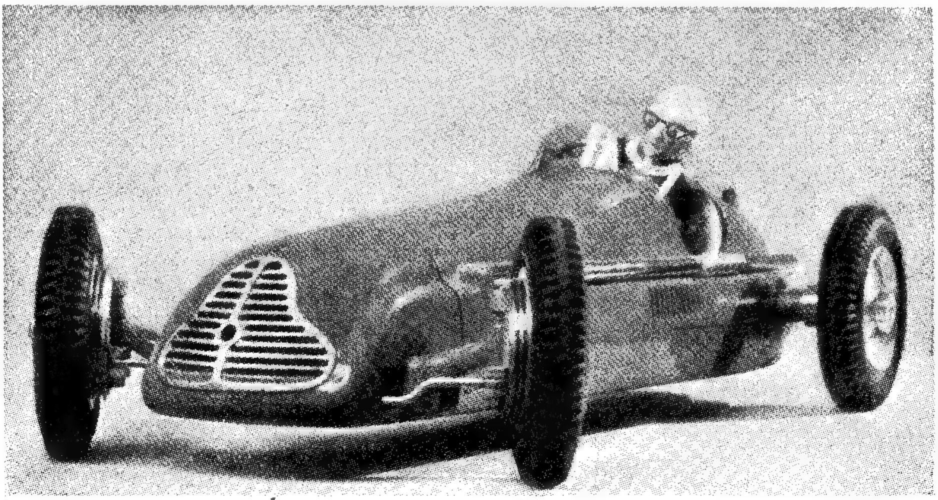
Now fill in the remainder of the tail with strips (*g*) worked to shape as described. Fit, scribe the overlaps of each strip, trim and solder in position. It will be noted that these strips will have to be wider at the tail end than the seat end and that the top ones will have more twist in them than the lower ones.

Some stiffening will probably be required to the lower edge of the body. Square-section brass rod, $\frac{1}{8}$ in. × $\frac{1}{8}$ in., is ideal for this purpose and when soldered on will be quite secure. Alternatively, round steel wire is quite serviceable. This should preferably be tinned before fitting, to be sure of [redacted] good joint, and in both cases the soldering should be continuous throughout its length.

Having completed the body assembly, file off any "lumps and bumps" of solder or high spots of the tinplate where cut or bent, using [redacted] coarse file. If you go through at any odd spot it can be "filled" with stopper or, if excessive can be patched by soldering [redacted] piece of tinplate inside.

Whether or not the final finish is to be cellulose or paint it will be found easier to use cellulose stopper for filling out to the correct curves, because it dries quickly and is easily rubbed down with "wet and dry" sandpaper, using water as [redacted] lubricant. Wash all grease and flux off the body first, then give it [redacted] coat of cellulose priming paint or any cellulose paint. Now fill all hollows, applying the material with [redacted] putty knife or similar flat tool. When dry rub down and if necessary apply [redacted] second layer. When the surface is satisfactory it can be finished by hand, or spray painting.

# Realism Runs Riot!



*This intriguing Italian model, the Autocorsa T.C., is as realistic as it appears in the photograph. Electrically powered, the Ackerman steering is operated remotely by a separate, smaller unit, and the speed, steering and gears are controllable by [redacted] operator some distance away. The driver, too, is functional, carrying out all the body and arm movements of the Grand Prix exponents in true racing fashion!*

# *Reminiscing with "Doc"*

*by G. W. Arthur-Brand*

A FEW nights ago, an old friend dropped in to see me. I hadn't seen him for over twelve years, the last occasion being at about 3 o'clock on a sweltering tropical afternoon, with the thermometer ranging 105 deg. + F. in the shade. The venue was the interior of a sugar-boiling vacuum pan which had been in action only a few hours previously.

I was leaving for England on the following day and as I had a number of duties to perform before embarking, I was determined that I would bid personal friends *adieu* that afternoon, come what may. Well, I was doing fine, and as I crawled through the man-hole, there was "Doc," stripped to the waist, a wet towel knotted like a turban about his head, grinning like a puma from ear to ear.

"I say," he greeted, "you're not taking Argentine Lil with you?"

Now before any of my readers start getting ideas, I'd better explain. Argentine Lil was the name affectionately bestowed upon a gadget I had knocked together from odd bits of junk when we were modifying an old boiler to act as a drinking-water tank. Several dozens of overhead holes had

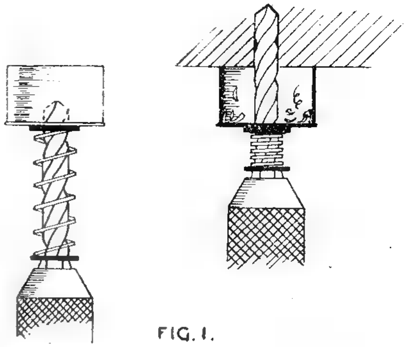


FIG. 1.

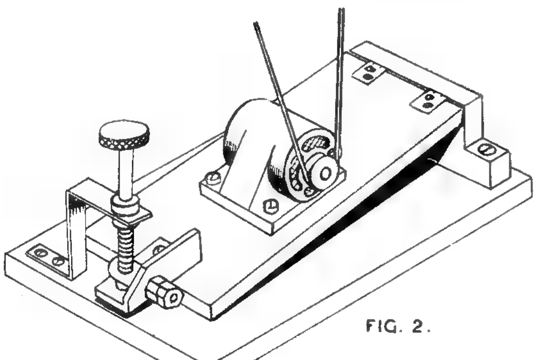


FIG. 2.

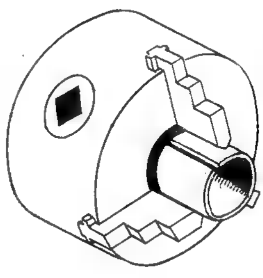


FIG. 3.

to be drilled from the inside and we soon decided that something would have to be done to keep the red-hot chips from our eyes and bare torsos. Fig. 1 explains how the problem was solved, with the aid of a tin which once contained "choice Argentine tongue," a brass collar sweated to the bottom and an odd compression spring picked off the junk heap. By pulling the tin towards the drill-chuck, the point may be directed to the centre-pop mark.

It was strange that we should both have remembered this little episode simultaneously, and when I mentioned my desertion of pure engineering for the inky way, Doc remarked, "Tell 'em about Argentine Lil." So, here she is, readers, and I hope you find her as co-operative as we did.

Reminiscences are apt to run riot when two model engineers get together after several years, and another gadget which came to mind was the very simple belt tensioner, Fig. 2, which I fitted to a very antiquated and overworked round-bed Drummond lathe; not over-ingenious, I admit, but extremely practical. No doubt many of you will wonder why Doc should have taken the trouble to remember the thing, in fact, but hereby hangs a tale; you see, Doc supplied the motive power!

Way out in the Leeward Islands, fresh air, sunshine and sea-water are free and plentiful; rum is incredibly cheap; but a good $\frac{1}{4}$- or $\frac{1}{3}$-h.p. electric motor—no; gold nuggets wouldn't buy one. So a tour is made of the various scrap yards until a rusty bicycle frame is encountered and purchased, or exchanged for a packet of cigarettes. After suitable treatment a comfortable seat is added, the whole contraption is painted a psychologically-inviting colour and you request the co-operation of your most manly acquaintance.

Doc's 13 stones were a gift from the gods, and, as a keen amateur weight-lifter and wrestler, he thrived in the odd hour's pedalling, bolstered, no doubt, by frequent visits from the butler, who had been well prompted regarding his duties during Doc's visits, with large quantities of iced milk and honey cakes. Doc's pet aversion, however, had always been the tendency of the belt to slip at the slightest provocation; hence, as a birthday present, the addition of the little gadget shown here.

The old lathe was used for all sorts of odd jobs

including wood-turning, and for a long time I had great difficulty in deciding just how to encourage pieces of round material to behave in a docile manner while being bored in the chuck. The very simple solution, illustrated by Fig. 3, will, I hope, be found useful to others who may find themselves in a similar position. The threads grip the end securely without any tendency to split the work, and if the turning operations—external and internal—are carried out at the same setting, there will be no danger of running out.

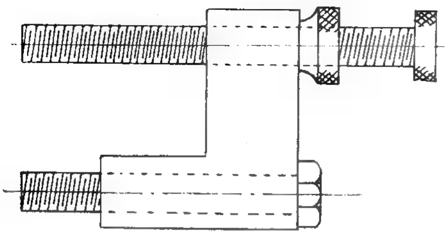


FIG. 4.

Unions are obtainable in a large number of sizes and if you intend to do a lot of wood-turning, it will probably be worth your while to prepare several of different sizes to be available as and when required.

A little gadget which saves a lot of time is the cross-slide stop, Fig. 4. Doc was always in a hurry and often, when taking a turn at the constructional end of the lathe, would overshoot his cross-feed and find himself with a minus diameter. I remember remarking to myself one night, " I'll have to put a stop to that," and, by Jove, that is precisely what I did do. No explanation should be necessary here, except that the dimensions will depend mainly on the size and type of lathe it is meant to fit.

I must tell you about K.C., who was a great favourite with everyone. He had been a stoker in H.M. Navy and had somehow contrived to awaken one morning to find his head resting gently in the lap of some fair maiden, and the roar of the Atlantic on the barrier reef just a faint reminder of his former occupation. He recovered from his native fever, but remained always enamoured to the thirst-creating qualities of a tropical existence, the quenching of which he had contrived to effect by the consumption of large quantities of " Nelson's Blood."

K.C. only ever had one grouse, and that was his inability to find the keyhole of his liquor case long before he had reached stauration point. Fig. 5 shows how Doc. solved the problem for him, and thinking there might be odd occasions when such a device may be found useful to the model engineer, I make no apology for its inclusion. In fact, treated with luminous paint and fitted to the kitchen or even the front door, I would go as far as to suggest that it might save many a sore word from a strict T.T. on a dark, winter's night.

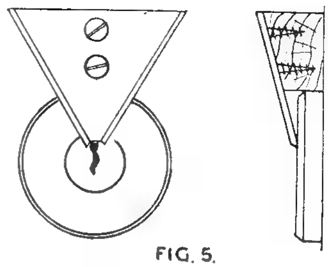


FIG. 5.

And now, finally, I'll tell you what Doc's parting question was.

" Bill," he said, " before I go, do tell me : what do the thousands of Mrs. ' M.E.'s ' have to say about their old men's activities ? I mean, it seems a pretty full-time job, for instance, making a $3\frac{1}{2}$-in. gauge locomotive ; are there no repercussions ? "

" Not a chance, Doc," I replied, my tongue pressed tightly into my cheeks ; " They all seem to spend at least 50 per cent. of their time making something for their wives."

So, glance quickly at Fig. 6, and then retire quietly to the workshop and make this simple sharpening device for your wife's scissors. They need to be sharp to cut a patch for those overalls you tore constructing the garden railway !

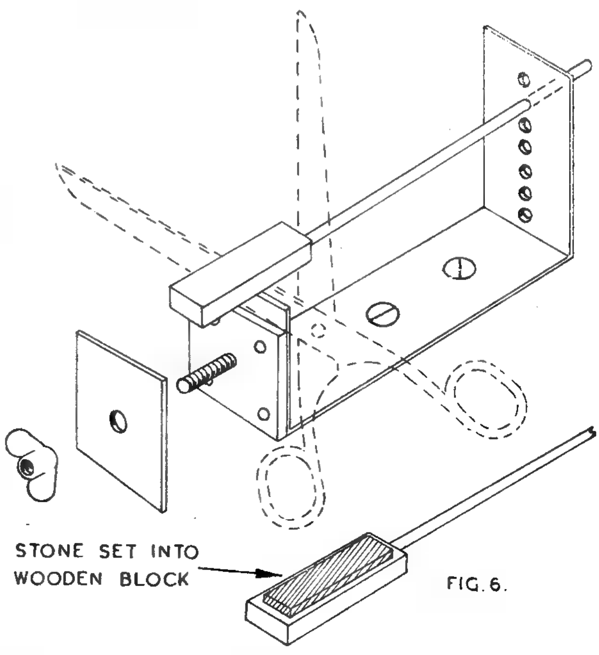
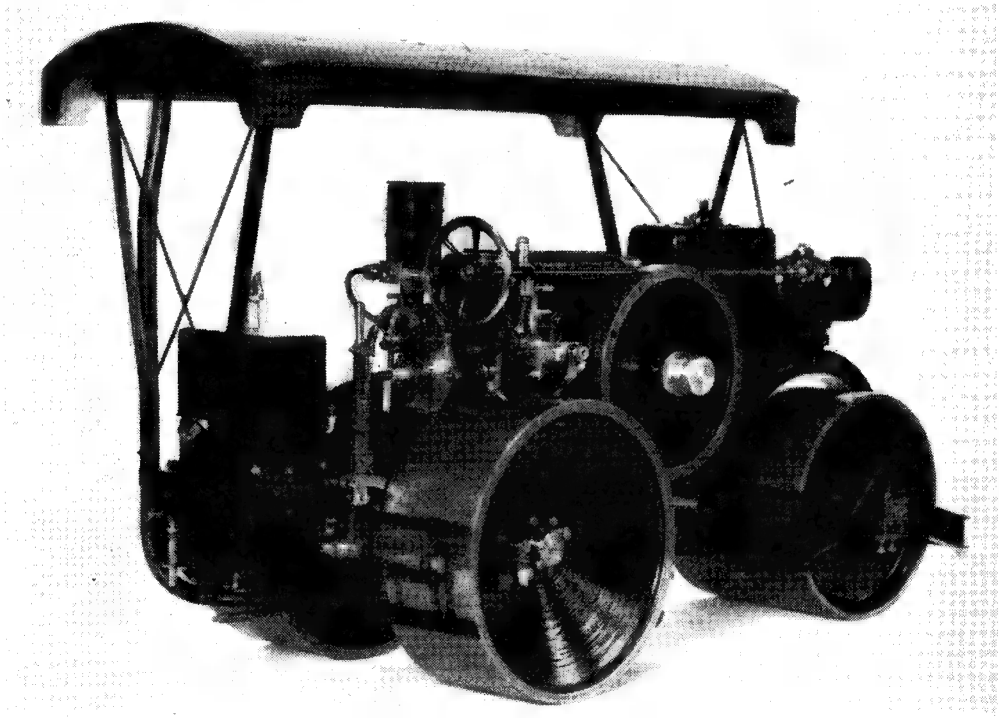



FIG. 6.

# *The Machining Tools for the "M.E." Road Roller

## by G. H. Walter

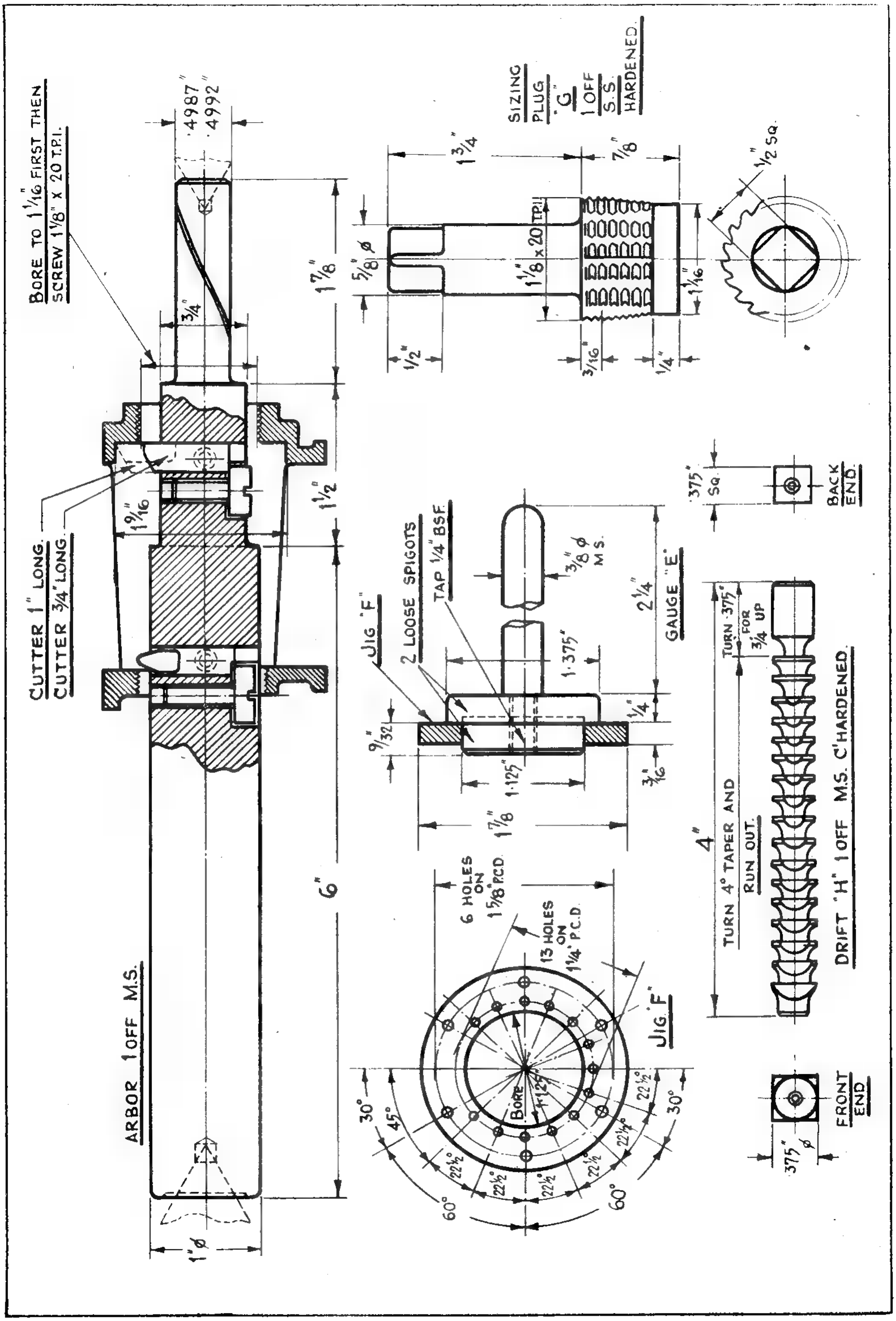
THE plug *B* is inserted in the crankshaft bore, then push in the boring bar and traverse the cross-slide until the headstock centre seats itself in the end of the bar. Tie the carrier to the driving plate by thick string at both ends. Insert the cutters, adjust and lock as shown in the drawing herewith and proceed to bore, taking light cuts and finally reaching finished diameter by setting plug *D* for the bottom hole and by setting plug *A* for the $1\frac{3}{8}$-in. hole. Remove the bar and check these two bores of $1\frac{1}{8}$ in. and $1\frac{3}{8}$ in. respectively with the plug gauge *E*. When all correct, replace the bar with the two longer cutters and face both the holes just completed simultaneously until the drawing dimensions are arrived at. One of the sketches shows the set-up with guide *B* in position. Oil can be fed to the small end of the boring bar through the $\frac{3}{8}$-in. hole in *B*. This completes both the bores.



*The rear end view of Mr. Walter's "M.E." road roller*

Next, mount the crankcase with its jig still in position and bolt to an angle bracket, which in turn is bolted to the cross-slide and with eccentrically set tool in the four-jaw chuck, face off the timing bracket face, the diagonal face and the water hopper face to the drawing dimensions. To ensure all these faces coming square, insert plug *B* in the crankshaft bore and push a length

*Continued from page 342, "M.E.," March 16, 1950.


BORE TO 1 1/16" FIRST THEN SCREW 1 1/8" x 20 T.P.I.
CUTTER 1" LONG.
CUTTER 3/4" LONG.
ARBOR 1 OFF M.S.
·4987"
·4992"
SIZING PLUG "G" 1 OFF S.S. HARDENED.
1/2 SQ.
1 1/8 x 20 T.P.I.
JIG 'F'
2 LOOSE SPIGOTS
TAP 1/4" BSF
GAUGE "E"
3/8" ø M.S.
·375" SQ.
BACK END
TURN ·375" FOR 3/4 UP
TURN 4° TAPER AND RUN OUT.
DRIFT 'H' 1 OFF M.S. C'HARDENED.
FRONT END
6 HOLES ON 1 5/8" P.C.D.
13 HOLES ON 1 1/4" P.C.D.
BORE 1·125
JIG 'F'

of about 10 in. of $\frac{3}{8}$ in. diameter silver-steel through the $\frac{3}{8}$ in. reamed hole in *B*. Make certain that the bar is straight, then line up the bar with the lathe bed both ways and proceed to face up.

The jig plate can now be removed. For drilling the crankcase holes, stand plug *B* on the drilling machine table to which it is bolted by a $\frac{1}{4}$-in. or $\frac{5}{16}$-in. bolt and nut. Slide the crankcase over it and finally drop jig *C* on the protruding spigot *B* to lay flat on the crankcase. Adjust the drill table so that the drill lines up with the $1\frac{13}{16}$ in. p.c. row of holes. Adjust the scribed centre-line on the drill jig to come parallel with the crankcase base and drill one hole. Insert a short piece of 3/32 in. diameter silver-steel in this hole through the jig, then swing the case and jig round, and drill all the remaining holes. Reverse the case and repeat the other side.

To drill the cylinder liner holes in the crankcase, clamp the case to an angle bracket under the drill, line up for squareness with *B* and the 10 in., $\frac{3}{8}$ in. diameter bar as before. Then remove the $\frac{3}{8}$-in. handle from gauge *E* and fasten the $1\frac{3}{8}$-in. and $1\frac{1}{8}$-in. discs together with a $\frac{1}{2}$-in. screw. Slip the jig *F* over the $1\frac{1}{8}$ in. diameter disc and insert the $1\frac{3}{8}$ in. diameter disc in the end of the crankcase. The centre-line on *F* must be at right-angles to the water hopper face. Then drill the first hole on the $1\frac{5}{8}$ in. p.c. row of holes, insert the 3/32-in. plug again and shift the angle bracket and job about under the drill to do the remaining five holes. Remove everything and tap these holes $\frac{1}{8}$-in. Whit. Finally, mark out and drill and tap all remaining holes in the crankcase, none of which require a jig. The inspection cover holes should be drilled through the actual cover. This completes the crankcase.

### Cylinder-head

Clamp jig *F* direct to the $1\frac{1}{8}$ in. register on the head, with its centre-line at right-angles to the carburettor face and drill eight holes only on the $1\frac{1}{4}$ in. p.c. circle (see official drawing) and six holes on the $1\frac{5}{8}$ in. p.c. circle. Open out the eight holes to 7/64 in. after removing the jig and open out the six holes to 0.136 in. with a No. 29 drill.

### Cylinder Liner

Bolt the $1\frac{1}{8}$ in. diameter disc of gauge *E* into the register on the outside end of the liner with a bolt through the liner to the drilling machine table. Lay the jig *F* over the $1\frac{1}{8}$-in. spigot and drill all holes in the same way as before with the 3/32-in. plug after the first hole. Centre-line on jig does not matter with the liner. Remove the jig and open out the water passage holes to 7/64 in. and the six holes on the $1\frac{5}{8}$ in. p.c. row to 0.136 in. with a No. 29 drill.

### Crankcase End-plates

These, after turning is completed, should be laid on the drill table and drill jig *C* placed over their $1\frac{15}{16}$ in. diameter spigots and drilled as before. Care must be taken to get the timing side end-plate located with the jig so that the centre-line on the latter is parallel with the skew gear bore.

### Transmission Motion Plates

First bolt the near side one to the faceplate and turn over the lugs, and clean up to the $1\frac{7}{8}$ in. dimension on the drawing. Next, take the offside plate and, gripping in the three-jaw chuck, face off the plain side of the casting to drawing dimension. Drill both plates and tap the near side one, and bolt them together. Lay the assembled parts on the surface plate and mark a centre-line right round, running through the centre of the two cast holes as nearly as possible. Mount on the lathe faceplate and adjust with packings if necessary to get this scribed line parallel all ways with the faceplate and turn away the top face to $\frac{7}{8}$ in. from the centre-line.

Now mark off the centres for the square transmission shaft on *both* ends of the assembled box, indent and drill centres with a Slocombe bit. Place between lathe centres and face up both ends of gearbox.

Remove lathe top slide and bolt on the jig used for the crankcase with the short end to the faceplate.

Place gearbox between centres again and with $\frac{1}{2}$-in. packings bolt to the jig, wind the saddle to the right and bore out the $\frac{7}{8}$ in. and $\frac{3}{4}$ in. ball-bearing holes, backfacing the latter, and finally drill and ream the $\frac{3}{8}$-in. hole in the centre boss.

Next, turn job and jig sideways, lining up jig with faceplate as before and drill and ream the $\frac{1}{2}$-in. hole on the centre boss. Mount jig and job with a boring bar through the two large cast holes as sketch herewith, and bore right through $1\frac{1}{16}$ in. and recess the farther hole for friction disc to $1\frac{9}{16}$ in. × 5/32 in. deep.

Lastly, with a tool bit ground or filed to fit the 20 t.p.i. thread gauge, screw right through the two bores. Owing to backlash or saddle wind, it is necessary to take the first cut right through, remove the bar, wind saddle back and repeat, each time with the cutter a little farther advanced until size is reached. Finally, remove case and pass plug gauge *G* through, which will round the thread crests and size up generally.

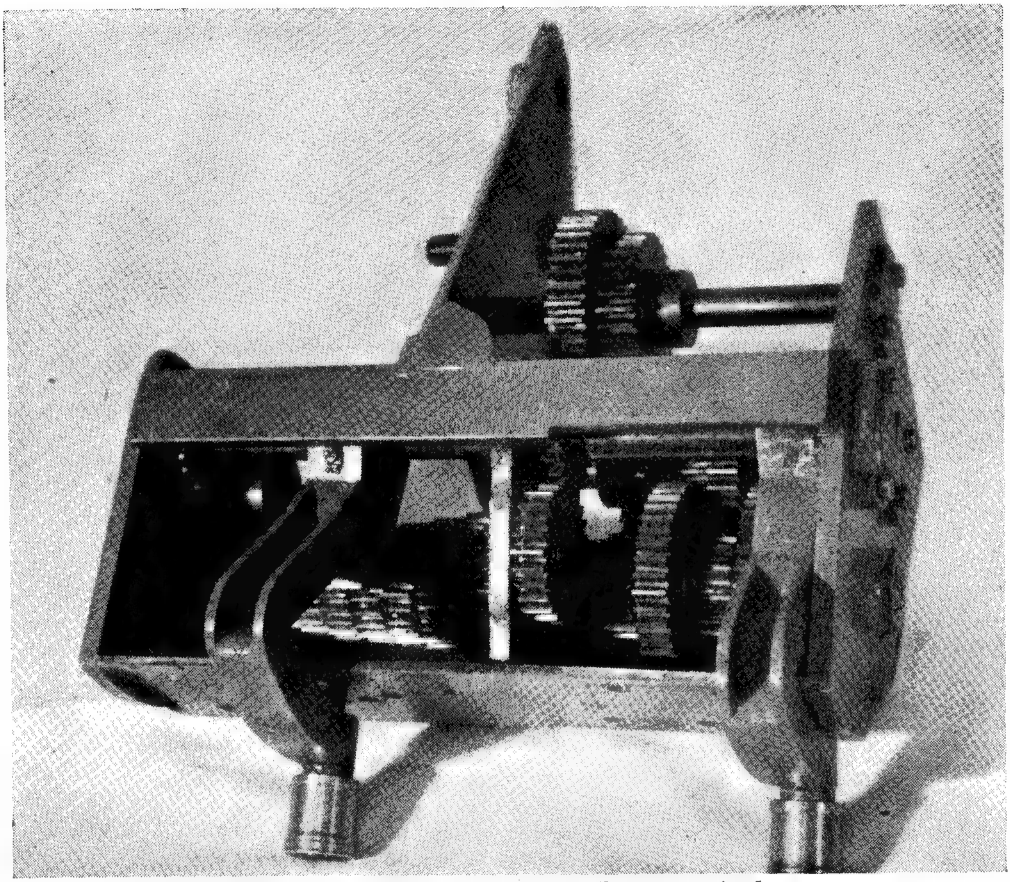
### The Friction Disc

The only other component which presented any difficulty was the friction disc itself. After turning and reaming the bore to $\frac{3}{8}$ in., a $\frac{3}{8}$ in. square is marked out round the hole and the job is then filed to within 0.010 in. of the line, when the broach or drift *H* is forced through in the vice. Release it occasionally and knock at the back to free chips, but continue until the broach goes right through. This disc must revolve without wobble and the method described makes a perfectly square hole, concentric with the outside diameter, as the broach has a $\frac{3}{8}$-in. pilot which is guided by the $\frac{3}{8}$-in. reamed hole.

[This article should be of great interest to the many readers who have asked our advice in respect of difficulties in machining the components of this popular model, with very limited tool equipment. While there are many satisfactory methods of attaining correct results in machining operations of this nature, Mr. Walter's methods are typical of the modern approach to these problems and ensure positive accuracy of the finished product.—ED., " M.E."].

# A Lathe Feed Gear-Box

## by G. A. C. Lynch



*Underside view of gear-box, showing built-up operating levers*

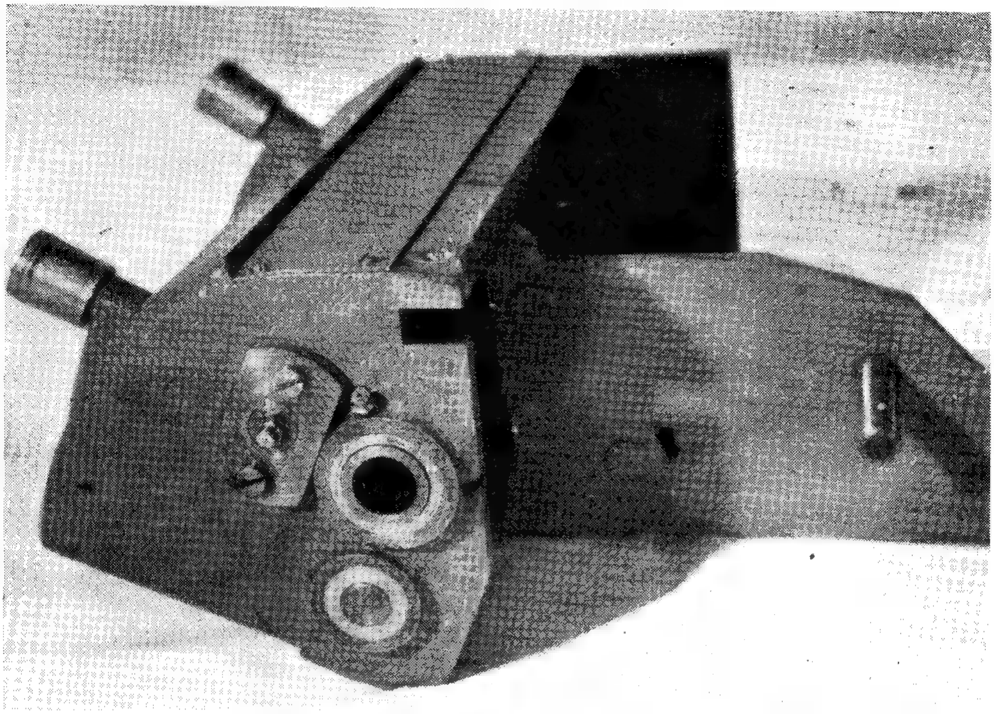
ONE of the many sources of satisfaction in the ownership of a lathe is that it is such a versatile tool ; in fact, starting with a good screw-cutting example, one can build up a machine tool which will handle work for which a less impecunious owner would use special machines.

But this potentiality of the lathe can be a source of irritation to the worker whose time is limited, not to mention his sorrowing wife and family who have to be introduced to the rites of making an accessory so that some new job can be tackled efficiently.

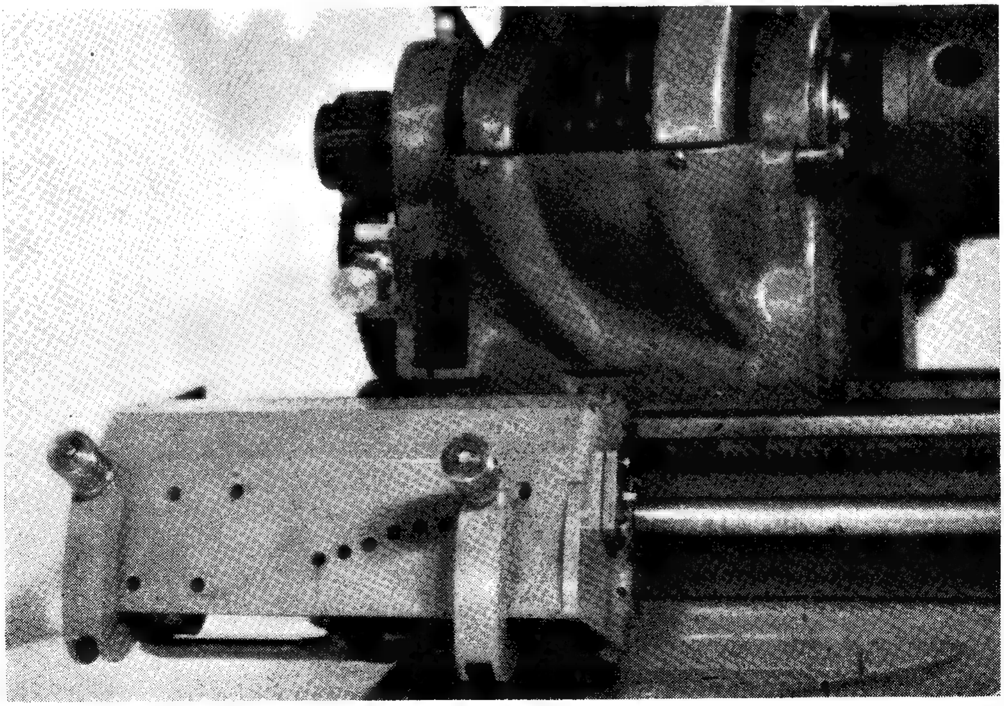
These additional fittings can be described as falling under two headings : first, those essential for certain accurate work, such as a good dividing-head, and secondly, fittings which though not essential will save endless time and trouble once they have been constructed.

The multi-feed gear-box falls into the latter group, and the one here illustrated was designed and built by the author as a result of the exasperation caused by loss of valuable time in changing from auto-feed to screw cutting for two different pitches, and back again to plain feed on a job where " several-off " were required, but where it was not feasible to remove the work from the lathe once it had been set up. Thus, one had to cut a long length with the self-feed, alter the change-wheels to cut a particular worm and then to alter them yet again to cut a coarse thread of large diameter. Such repeated dismantlements of the change wheel set-up became too much of a good thing to be contemplated in the future, so the gear-box was decided upon as the next item on the equipment programme.

(*Continued on page* 397)



*End view, showing bearing provided for lead-screw*



*Gear-box in position on the lathe. The new reverse lever is also visible*

# IN THE WORKSHOP

## by "Duplex"

### 59—*Building the $\frac{3}{8}$-in. Cowell Drilling Machine from Castings

THE headstock is already bored an accurate sliding fit on the ground steel column, to which it is secured by means of two Allen grub-screws. The housings for both the quill and the upper spindle bush are also machined to size, as well as the housing for the pinion shaft. The first operation is to clean up and finish the faces of the bosses indicated as *A*, *B*, *C*, *D* and *E* in Fig. 1; the face *F* is already machined and can, therefore, be used as a datum surface. As all these surfaces, except *A*, are not working surfaces, they need only be finished to the dimensions given in the blueprint, and no particular accuracy is required. The easiest way, perhaps, is to mark-out the casting while standing on its face *F* on the surface plate or, as an alternative, the parts of the machine are assembled and the surface gauge then stands on the drill table.

If a large lathe is available, the casting can be mounted on a mandrel and the outer ends of the bosses faced in the ordinary way, but it is hardly worthwhile, or necessary, to set-up the casting on the boring table of a small lathe for this operation.

These surfaces can quite well be finished by filing to the scribed lines, and, when doing this, a piece of faced material inserted in the bore can be used to act as a filing gauge.

It is important that the face *A* should be accurately finished, as it forms a working face for the spacing washer on which the driving pulley rests.

In addition, the U-shaped contour, shown at *G* in Fig. 1, should be filed to shape and at the same time any surface irregularities on other parts of the casting should be cleaned up to render the headstock ready for painting at a later stage.

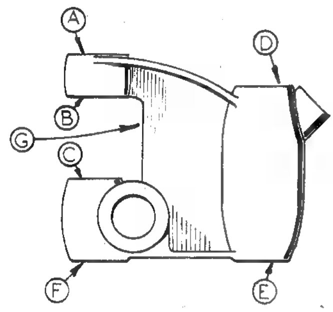



*Fig. 1. The headstock casting, showing surfaces which require finishing*

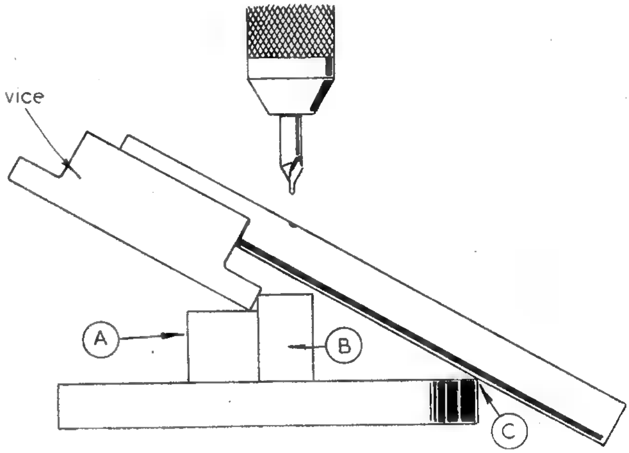



*Fig. 2. Showing a method of angular drilling the pinion shaft*

#### The Rack Pinion Shaft

The only operation of any difficulty in machining the pinion shaft is the angular drilling of the hole to receive the feed handle, and, as when doing this, burrs and other irregularities may be set up, it is advisable to drill and tap this hole before turning the shaft to its finished diameter. When the hole centre has been marked-out, it should be deeply centre-punched to form an adequate guide centre for the centre drill which has to make a start on the inclined surface. For lack of an angular drilling table, the vice itself was set to the correct angle with the aid of a protractor. As shown in Fig. 2, the edge of the vice base rests on a packing strip *A*, and is kept from slipping towards the right by the strip *B* which is clamped to the drill table; the overhanging end of the shaft is meanwhile supported against the edge of the table at *C*. The hole should be started with a small centre drill, and preferably one which has had its pilot portion shortened by resharpening, for the side thrust arising when the coned part of the drill meets the work will tend to break off the drill tip. A second, larger centre drill is then used to enlarge the mouth of the hole to the full clearance diameter of the thread. A clearing size drill is next entered to a depth sufficient to enclose the base portion of the handle when screwed into place; this is followed by the

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*Continued from page 328, "M.E.," March 9, 1950.

tapping size drill. It is advisable to employ the drilling machine to tap the hole while the shaft is still mounted in the vice at the proper angle, for it is not easy to gauge this angle correctly when hand-tapping is resorted to.

After the pinion shaft has been turned to the dimensions given to make it a good fit both in the housing and in the pinion itself, the key seat for the key, used to locate the pinion, is machined

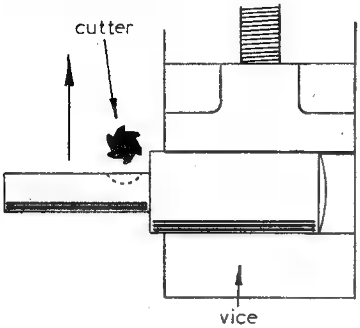



*Fig. 3. Cutting the key seat in the pinion shaft*

with a $\frac{1}{2}$-in. dia. circular Woodruff cutter in the manner illustrated in Fig. 3. The large end of the shaft is secured in the machine vice attached to the vertical slide, and the cutter is fed in to the full depth by raising the vice with the slide feed-screw. The cutter must first be centred on the shaft as illustrated in the Fig. 4. The face of cutter is brought into contact with the shaft, Fig. 4 (a), and the reading of the leadscrew index is taken; next, the saddle is traversed towards the headstock for a distance equal to half the thickness of the cutter, plus half the diameter of the shaft.

When the cutter has been correctly centred, both the lathe saddle and the cross-slide are locked, and the cutter is then brought into contact with the shaft to allow the index of the vertical slide feed-screw to be set to zero. The key seat is now cut to the correct depth, $\frac{1}{8}$ in. in this instance,

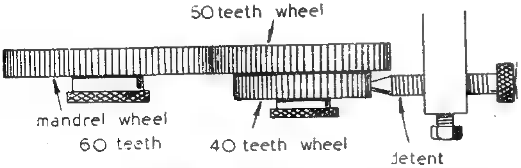



*Fig. 5. G ar train and detent for indexing the feed collar*

by reference to feed-screw index as the work is moved upwards.

The key itself is turned from a piece of round steel to a dia. of exactly $\frac{1}{2}$ in. and is then parted off a few thousandths of an inch in excess of its finished thickness.

The disc so formed is next cut across with a hacksaw, and the portion used for the key is filed to a height equal to the depth of the key seat, plus the depth of the keyway in the pinion; but when fitting the key, it should not actually bottom in the keyway. The key is carefully rubbed on a fine file until it is a good fit in the key seat and is, at the same time, a sliding fit in the keyway. On no account should the pinion be forced on to the key when in position in the shaft, for a firm push-fit is all that is required and, moreover, this allows the parts to be dismantled if required.

The machining of the spring box and the fitting

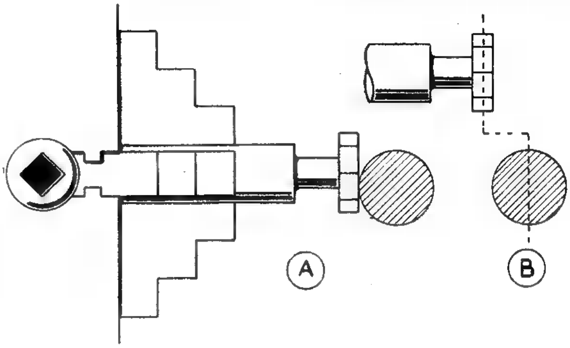



*Fig. 4. Centring the key seat cutter on the pinion shaft*

of the feed handle are both straightforward operations requiring no particular comment.

**The Feed Index Collar**

When a short length of material is used to make the circular feed scale, it may be gripped in the chuck and bored to a dia. of, say, $\frac{1}{2}$ in.; the hole for the locking-screw is then drilled and tapped. Next, a stub mandrel is turned to fit the bore in the collar and a flat is filed on it for the locking-screw. If the blank is now mounted on this mandrel and secured by its locking-screw, the collar can be turned to size, the flange knurled, and the graduation lines cut; following this, the work is reversed on the mandrel to enable the back surface to be turned and chamfered. When it comes to graduating the collar, it will be found that the rack has a pitch of $\frac{1}{8}$ in. and, likewise, the 24-tooth rack pinion has a circular pitch of

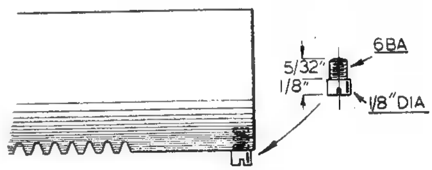



*Fig. 6. Showing the stop screw fitted to the lower end of the quill*

$\frac{1}{8}$ in. If, therefore, the collar is divided into 48 divisions, each of these will represent a feed movement of $\frac{1}{16}$ in. This indexing can be carried out by securing a 60 T. wheel to the tail of the mandrel, and mounting on the first stud of the quadrant a 50 T. and a 40 T. wheel keyed together. If, as shown in Fig. 5, the 50 T. wheel is meshed with the mandrel wheel, the 40 T. wheel, when controlled by a detent, will then serve to index the divisions required.

As has been previously described, a cord,

wound round the body of the chuck, is tied to the chuck key, and a weight, attached to the further end of the cord and hanging over the edge of the bench, is used to take up the backlash in the gears and prevent the work turning under the pressure of the cut. The graduation lines are cut with a V-pointed tool mounted on its side at centre height in the lathe tool post. In practice it has been found that a tool, with a point formed to an included angle of 45 deg., cuts a well-proportioned line when fed in to a depth of 4 thousandths of an inch in two successive stages of 2 thousandths.

It will be apparent that the $\frac{1}{16}$ in. graduations on the collar will be more than this distance apart; in fact, the spacing is approximately 0.086 in. for an index of $1\frac{5}{16}$ in. dia.

Because of this, in order to avoid confusion, it is advisable to make the scale lines of a length that can be clearly read and differentiated. These lines are cut to the required length by reference to the leadscrew index while traversing the lathe saddle, and, in connection with a leadscrew of $\frac{1}{8}$ in. pitch, the following dimensions have been found to give a satisfactory result.

| *Scale line* | *Length of line* | *Leadscrew index* |
|---|---|---|
| $\frac{1}{16}$ in. | 0.075 in. | 0-75 |
| $\frac{1}{8}$ ,, | $\frac{1}{8}$ ,, | 1 turn |
| $\frac{1}{4}$ ,, | $\frac{3}{16}$ ,, | $1\frac{1}{2}$ turns |
| $\frac{1}{2}$ ,, | $\frac{1}{4}$ ,, | 2 turns |
| 1 ,, | $\frac{5}{16}$ ,, | $2\frac{1}{2}$ turns |

After the graduation lines have been cut, the collar is removed from the mandrel and gripped by its plain portion in the chuck, but the finished surface must be protected from damage by the chuck jaws with a strip of thin card. The bore is then enlarged to fit the pinion shaft, and the end of the part is finish-faced and chamfered.

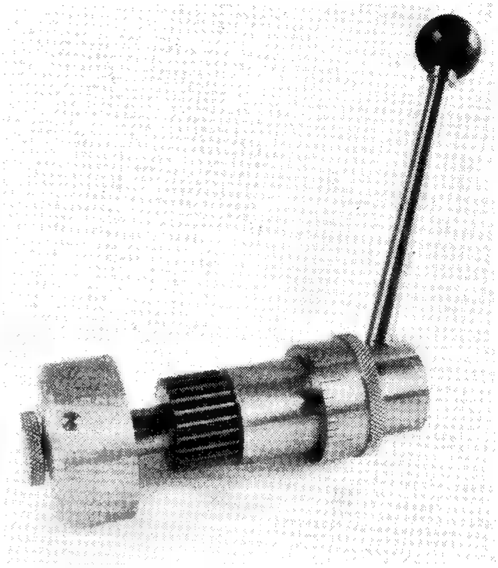


*Fig. 7. The feed shaft assembly*

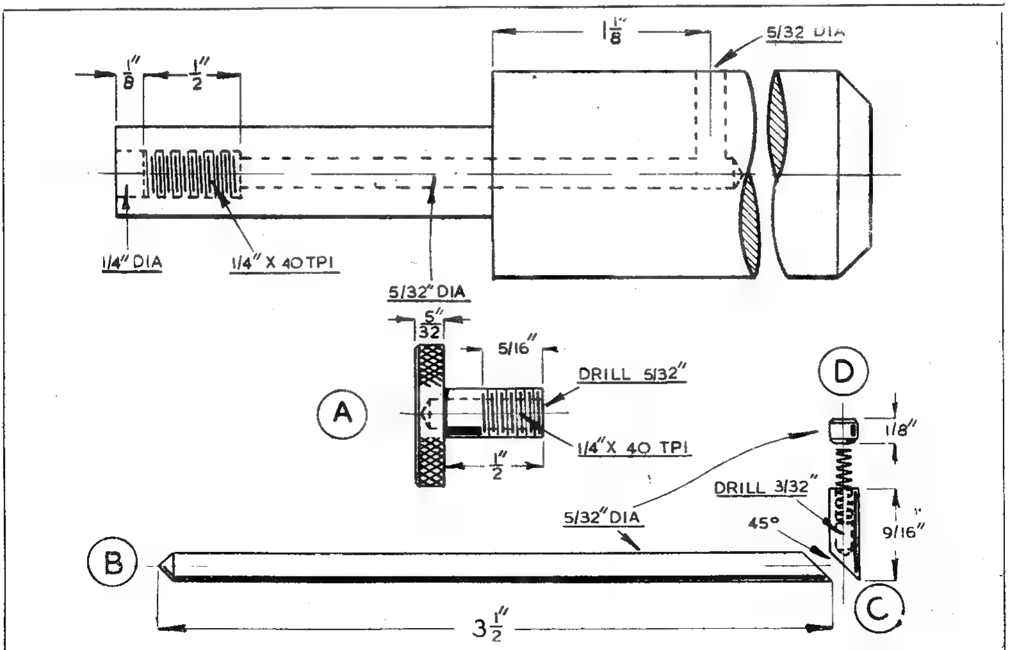



*Fig. 8. Constructional details of the alternative form of lock for the index collar*

## Modifications to the Feed Gear

When building the machine, the following modifications were introduced purely as a matter of personal preference and not with the idea of improving on the design ; builders are, therefore, at liberty to discard these suggestions or, if so minded, they can adopt any alterations that are to their liking. In the first place, it was decided to give the bushing carrying the spindle driving pulley a longer bearing in the headstock casting ; this entailed limiting the upward travel of the quill in order to prevent the spindle collars coming into contact with the lower end of the bushing. A stop-screw was therefore fitted to the lower end of the quill as shown in Fig. 6, and this reduces the spindle feed by approximately $\frac{3}{16}$ in.

The photograph in Fig. 7 shows that the spring box was left plain, instead of being knurled, but its edge was deeply chamfered to match the bevel at the other end of the pinion shaft.

The outer end of the spring itself was secured to the box by means of a 6-B.A. screw inserted from within. To form the hole for the screw, support the end of the spring on a piece of brass and make an indent with a centre punch ; then file off the pip formed on the underside, and repeat these operations until a small hole is made which, it will be found, can quite readily be enlarged to the finished size with an ordinary twist drill.

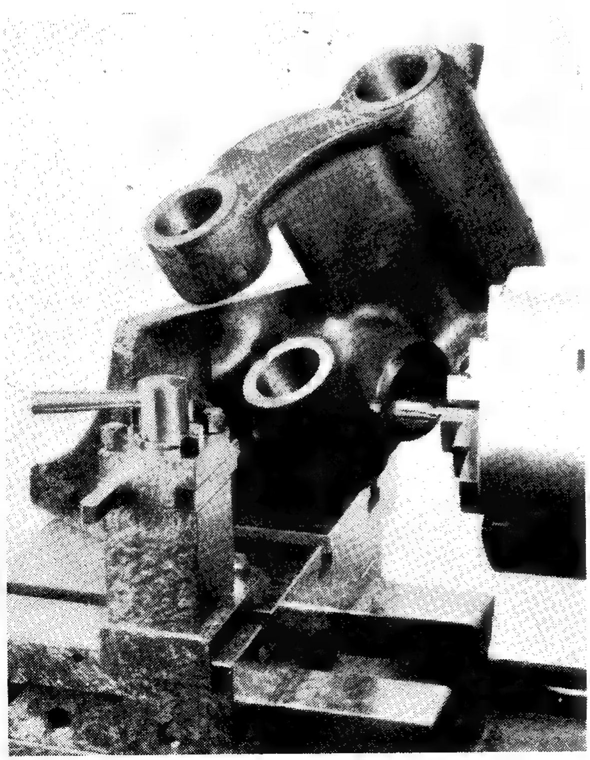


*Fig. 9. Machining the headstock casting for the index line*

A $\frac{1}{8}$ in. dia. hole is drilled in the rim of the box, opposite to the clamping-screw, to take a short tommy-bar for use when adjusting the spring tension. The 2-B.A. clamping-screw, which secures the spring box to the pinion shaft, is

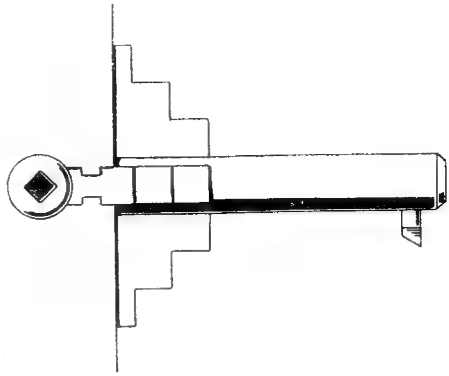


*Fig. 10. Boring bar with V-cutter for machining the index line*

provided with a brass pad-piece to protect the spindle from injury. The recess turned on the pinion shaft shoulder, to aid removal of the pinion, can also be seen in Fig. 7.

Although the $\frac{1}{8}$ in. dia. pin which forms the anchorage for the inner end of the spring is shown in the blueprint as a force fit in the headstock casting, it is, perhaps, better to screw this pin into place so that it can be removed for the machining operation, at a later stage, on the lug carrying the jockey assembly. The machining of the graduated index collar was facilitated, in the present instance, by using a piece of material of sufficient length to allow all of the essential work of knurling, indexing and boring to size to be completed at one setting ; it was then only necessary, after parting-off, to reverse the part in the chuck facing for and chamfering the back surface.

## Locking the Index Collar

Instead of fitting a radial clamp-screw for locking the index collar, as shown in the blueprint, an alternative method was adopted whereby light turning pressure applied to the knurled screw, seen at the extreme left of Fig. 7, gave a secure lock. This obviates the necessity of using two hands for this simpe operation and, at the same time, there is not the danger of displacing the index with a screwdriver after it has been set. Furthermore, a grub-screw in this situation is always a little unsightly and, if conveniently placed, it is apt to encroach on the scale graduations.

The working drawings of the arrange-

ment are given in Fig. 8, where it will be seen that a knurled finger screw *A* impels an axial push-rod *B* against a radial rod *C* which, in this way, is forced against the inner surface of the index collar and locks it to the pinion shaft. The contact surfaces of these two rods are formed to an angle of 45 deg. in order to transmit the necessary motion. The radial rod *C* is drilled axially to house a short length of compression spring which, acting on the brass pressure-pad *D*, maintains frictional contact with the index collar and thus controls its movement; when, however, the rod *C* is driven further outwards, the spring is closed and the pad is forced directly against the index collar, which then becomes locked to the shaft.

An ordinary 5/32-in. drill will not be found long enough to drill the axial hole for its full length, and the drilling operation should be completed by employing a D-bit made from the same length of silver-steel as is used for the push-rod.

When using this device as a gauge for depth drilling, the drill point is brought into contact with the work by moving the feed lever with the right hand; the left hand sets the index to the zero position and then tightens the locking-screw.

## Cutting the Index Line on the Headstock Casting

To enable the scale on the collar to be easily read, it is essential that a properly formed index line should be cut on the flange of the headstock casting and, moreover, this line should stand out clearly against a well-finished background. It may be found possible to form both the ground and the line itself by filing, but any inaccuracy or lack of finish will be a perpetual eyesore and will reproach the worker whenever he uses the machine. It is therefore advisable to make sure of getting a good result by using a machining process in this instance.

The work must first be marked-out by painting the face of the pinion shaft housing with marking fluid, and when the shaft with its index collar is inserted in the housing, a line is scribed along the edge of the index to denote the depth to which the casting has to be machined. At the same time, the position of the index line is also marked on the casting, and this should be located where it can be easily read when the machine is in use.

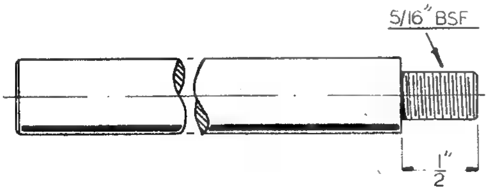



*Fig. 12. The modified jockey pulley bracket shaft*

Next, the headstock casting is bolted to an angle-plate attached to the lathe cross-slide, as illustrated in the photograph, Fig. 9. The centre of the bore of the shaft housing is adjusted to lie at lathe centre height, and the casting itself is set obliquely so that a ¼ in. dia. end-mill, mounted in the chuck, will cut a cone-shaped depression to carry the index line; the scribed line denoting the position of the index line is aligned with the cutter by rotating the casting on the bolt in the pinion housing which clamps the headstock to the angle-plate. The cross-slide should be locked during the machining operation, and the work is fed to the cutter by means of the leadscrew feed. Light cuts should be taken, and the machining is continued until the recess formed almost reaches the scribed depth line. To form the index line, the lathe mandrel is locked and a boring tool of the "Nulok" type, shown in Fig. 10, is mounted in the chuck in place of the end-mill.

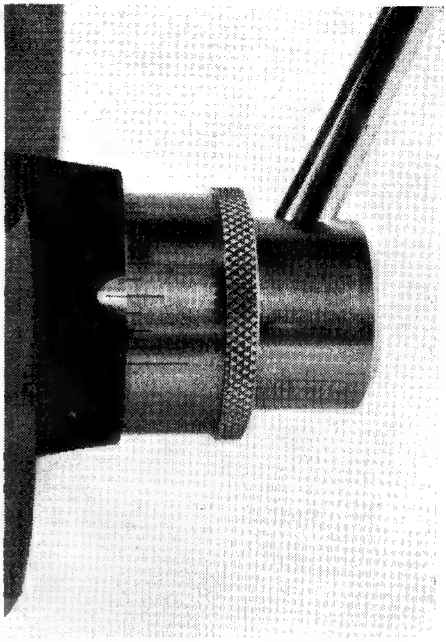


*Fig. 11. Showing the graduated feed collar and its index line*

The inset, V-pointed cutter is set with its cutting edge pointing forward and exactly at lathe centre height. The saddle is then traversed as before, taking a succession of light cuts until a depth of 6 thousandths of an inch is reached and, at the same time, making the line, say, ⅛ in. in length. Finally, the end-mill is again used to take a light cut in order to clean up and finish the surface. The result obtained in this way should have the appearance shown in the untouched photograph, Fig. 11.

## Mounting the Jockey Pulley Bracket Shaft

The method illustrated in the blueprint for attaching this part (7/26) is to form a ½ in. dia. hole in the headstock casting at an angle of 45 deg., and then to press the shaft into place after its end has been straight-knurled. Although this method is largely used commercially with good results, it may not, however, always appeal

*Fig. 13. The casting set up for machining the boss carrying the jockey pulley shaft*

to the amateur, who may prefer to spot-face the casting and then drill and tap it, say, $\frac{5}{16}$ in. B.S.F. The shaft is accordingly shouldered down, as represented in Fig. 12, and then screwed firmly into place.

To prevent any possibility of the shaft turning when in use, a grub-screw may be fitted to the casting to engage a dimple formed in the shaft.

To machine the headstock for mounting the jockey pulley shaft, the casting is secured to the lathe cross-slide by a T-bolt passing through the pinion shaft housing, as shown in Fig. 13; the casting is then aligned at 45 deg. with the aid of a protractor bearing on a length of shafting inserted in the quill housing.

It is advisable to remove the surface scale and level the surface of the boss with a file before the casting is set up in the lathe.

The machining is carried out by taking one or more cuts with a fly-cutter or facing-mill until a level surface is obtained.

If, in the first place, the centre of the boss was set to lathe centre height, a centre drill mounted in the chuck can now be fed in centrally in the boss, and this is followed by the tapping size drill and the corresponding tap. Finally, the underside of the boss is drilled and tapped for a No. 2 B.A. grub-screw, which is fitted to secure the jockey pulley shaft after it has been screwed in place.

(*To be continued*)

# A Lathe Feed Gear-Box

(*Continued from page* 390)

It was produced entirely on the lathe for which it was intended and no castings whatever were used, the box itself being fabricated from mild-steel plate with the capable assistance of "Sif-bronze." The gears were cut to the same pitch as the existing change-wheels of the lathe (16 D.P.) and all bearings were bushed with bronze.

## Odd Ratios

It was so designed that it incorporated the original change-wheel quadrant, so that odd ratios not provided for could be obtained; also that its attachment to the lathe should not require any new holes to be drilled, the bolts by which this is done being those used for holding the bevel reverse gear-box originally fitted to the lathe and which the new box replaces. A third attachment point is provided at the rear of the lathe bed.

Removal of the existing bevel gear-box entailed the provision of an alternative reverse and neutral arrangement: the one chosen is the usual pattern found on amateurs' lathes, but with an additional wheel giving easier disengagement under load. This was also built up from standard sections of mild-steel and bronze welded.

## Lever Manipulation

By the manipulation of two levers forty-five thread pitches, ranging from 8 to 120 t.p.i., are instantly available, and by changing one gear on the quadrant an addition nine ratios can be obtained. All B.S.F. and B.S.W. threads are covered up to 2 in. diameter as well as "M.E." and numerous other standard pitches.

Nine carriage feeds are available ranging from 0.007 in. to 0.004 in. and consequently a similar range is available for the cross-feed.

The design is straightforward and it should be a simple procedure to adapt it to many of the screw-cutting lathes used by model engineers.

# Electrical Test Instruments

## by E.T.P.

IN October last, Mr. A. R. Turpin described in THE MODEL ENGINEER how he converted surplus aircraft instruments into a number of multi-scale test instruments. I, too, have constructed such instruments, and can endorse the effectiveness of Mr. Turpin's methods ; but mine are not Chinese copies, and I have introduced modifications which may be of interest to others.

The aircraft instruments described by Mr. Turpin have a dial diameter of only $2\frac{7}{8}$ in., and a pointer $1\frac{7}{8}$ in. long. As ■ deflection of 90 deg. is about the maximum which can be expected the actual scale length is less than 3 in. measured as a circular arc, and this is rather small for accurate reading. I found it quite possible without detriment, to lengthen the pointer by $\frac{1}{2}$ in. or so, increasing the scale length by some 25 per cent., and this makes a tremendous difference to the ease of reading.

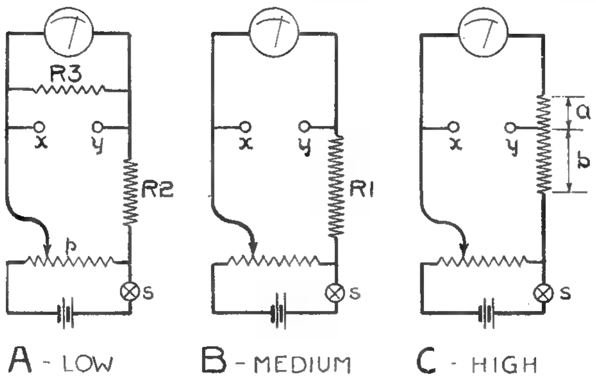



*Fig. 1. Ohmmeter connections*

Unless one goes to the trouble of dismounting the movement, a procedure which I certainly would not recommend to the inexperienced, the adding of an extension to the pointer calls for a considerable degree of care and a steady hand. The method is to hold the movement by the " tail " which carries the balance weight, grasping this in a pair of tweezers held in the left hand. The hand should, of course, rest on a firm support arranged at a convenient height. The extension piece, with a little dab of " Durofix " on the end, is held in the right hand, and pressed with a sliding movement on to the underside of the pointer. The pointer is slightly hollow on the underside, and this assists both the adherence and the alignment.

For easy reading, the extension piece should be very thin and I experimented with many materials. Perhaps the best is ■ bristle (taken from ■ domestic broom) but it is necessary to choose carefully for straightness. An alternative which in many respects is better, but unfortunately is much heavier, is a piece of wire. Take ■ length of, say, No. 36-s.w.g. wire, hold one end in a vice and the other in a pair of pliers, and stretch almost to breaking point. The overstrained wire is very hard and stiff and, of course, is perfectly straight, and it makes an ideal pointer, if the movement is robust enough to take the weight.

The weight of the extension piece must be balanced by an additional weight on the " tail." This can be ■ loop of wire, slipped over the existing balance weight, using the tweezers to adjust its position until the pointer does not move when the instrument is tilted. A tiny dab of " Durofix " will finally fasten it in position. Take care, of course, that the dab is a tiny one, or it may upset the balance.

As far as the internal connections are concerned it is in my ohmmeter that I differ principally from Mr. Turpin's instrument. I have one scale only, with a single pair of terminals to which the unknown resistance is connected, but the one scale gives me three ranges of measurement depending on the position of ■ selector switch. The internal connections corresponding to the three positions of the switch are shown in Fig. 1. The switch which makes the change-over from one to another of these connections is omitted for clearness. It is of the wafer type, and is ■ three-pole, three-way variety.

The connections for the " low " and " medium " ranges follow normal practice, but the connections for the " high " range are somewhat unusual. In all cases the switch $S$ is first depressed and the potentiometer $p$ adjusted until the meter indicates " infinity." The unknown resistance is then connected to the terminals $x$, $y$, and the value of the resistance will then be indicated on the dial, the reading being multiplied by the appropriate multiplying factor, according to the range selected.

In the usual method for measuring high resistances the unknown resistance is connected in series with the meter, so that the higher the resistance the smaller the current. On the other hand for low resistances (which are connected in parallel with the meter), the higher the resistance the larger the meter current. Thus the meter must have at least two scales on the dial, one reading in the opposite sense to the other.

With the arrangement shown in Fig. 1, however, it will be seen that the unknown resistance is always in parallel with the meter, so that the reading is always in the same direction, and by proper adjustment of the resistances one single scale will suit all three conditions.

Unfortunately, the method has its limitations as will be explained later.

The only difference between the *C* connections and the *B* connections is that, in the former, terminal *y* is connected to a point dividing the resistance into two parts, *a* and *b*. The total resistance in both cases is the same—as it must be, of course, if we are to have the same "infinity" setting.

It can be shown that if the multiplying factor as between the *C* connections and the *B* connections is *n*, i.e. if we want the same reading on the dial when the unknown resistance with the *C* connections is *n* times as great as with the *B* connections then the following algebraic expression must be fulfilled :—

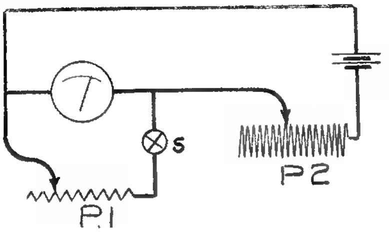



*Fig. 2. Measuring meter resistance*

$$nr(a + b) = b(a + r)$$

In this expression *r* is the resistance of the meter itself, and knowing this, the method is to choose any value for *a* and then work out the corresponding value for *b* to fulfil the equation with the desired value of *n*. There is an infinite number of values for *a* and *b* which will fulfil the requirements, and the choice would be made of any pair the sum of which gives a convenient value for *R*1.

In my case the meter resistance is 350 ohms, and taking *n* as 10, suitable values for *a* and *b* are 4,100 ohms and 15,100 ohms respectively. The sum, 19,100 ohms, is a convenient value for *R*1 for use in connections *B*, for the meter requires 0.00015 amps. for full-scale deflection, and the required value of voltage from the potentiometer is therefore 2.8 volts. I use a 4-volt flashlamp battery with a potentiometer of about 150 ohms.

Now the limitation of the method is that if *n* is chosen too large, or if the meter resistance itself is high, then no convenient values for *a* and *b* can be found, and the method cannot be used. As an indication, the maximum possible value for *n* is about equal to one quarter of *R*1 divided by *r*.

The method of calculating the resistances *R*2 and *R*3 in the *A* connections is simple. If with the *B* connections the same reading is to be obtained with an unknown resistance *q* times as large as with the *A* connections, then resistance *R*2 must be equal to *R*1 divided by *q*, and *R*3 must be equal to the resistance of the meter divided by $(q-1)$.

In my case, *q* is 10, and *R*2 and *R*3 are respectively 1,910 ohms and 39 ohms.

The 39 ohm resistance is a coil of resistance wire, but the ohms are the ordinary carbon type resistances as used in wireless. It is not necessary, of course, to try to buy resistances of the exact value required. If you get resistances rather lower than you require you can increase the resistance as required by reducing the section by filing or grinding.

The calculation of the resistances necessitates a fairly accurate knowledge of the resistance of the meter itself and this is not easy to measure directly. A method I have adopted is to connect a variable resistance *P*1 in parallel with the meter, with a high-resistance potentiometer *P*2 in series with both as shown in Fig. 2. With the switch *S* open, adjust *P*2 to give any deflection on the dial. Then close the switch and adjust *P*1 until the deflection is exactly half what it was before. Then the resistance of *P*1 is the same as that of the meter. *P*1 is disconnected from the current, taking care not to disturb its setting, and its resistance measured by any of the normal methods. The accuracy of this method depends upon *P*2 being a very high resistance compared with the meter resistance so that the total current given by the battery is not appreciably affected whether *S* is open or not.

One other point about the ohmmeter is worth mentioning. The switch *S* in Fig. 1 can be of the push-button type, so that it has to be pressed all the time a reading is being taken, and there is no possibility that the battery is left in circuit inadvertently when the instrument is put away. If, however, you are an inveterate instrument tapper, as I am, you haven't enough hands to press the switch, adjust the "infinity" setting, and do your tapping all at the same time. This suggests a plain on-off switch, but I have found it is the easiest thing in the world to forget to switch off, and you find your battery dead next time you want to use the instrument. A solution is to fit a pilot lamp. A 2½-V torch bulb takes about 0.1 amp., but will light sufficiently for the purpose at something less than this. The additional burden on the battery is therefore not excessive if you use a 2½-V bulb with a length of resistance wire in the series.

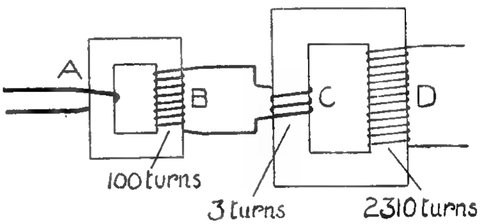



*Fig. 3. Transformers in cascade*

Turning now to other instruments, my voltmeter follows conventional lines, but there is a point of interest in the ammeter. I wanted a series of current ranges, the largest being 0-10 amp. Now, the movement used in this case required an a.c. current of 0.000130 amp. r.p.m. supplied through a rectifier, so that using an ordinary current transformer I should require a turn ratio of 10 divided by 0.000130, which equals 77,000. Even if the primary consists of one single turn, the secondary winding would have to be a coil of 77,000 turns. The winding of such a coil

I considered quite impractical and in seeking some alternative solution I hit on the idea of using two transformers in cascade, the secondary of one feeding the primary of the other. The basic idea is illustrated in Fig. 3. With the number of turns shown, a current of 10 amp. in the primary *A* of the auxiliary transformer provides 0.1 amp. in the secondary winding *B*. This current flowing in the three turns of the primary winding *C* of the main transformer produces the required current of 0.000130 amp. in the secondary winding *D*.

An objection which springs to the mind is that two transformers mean twice the iron loss, and iron loss in a current transformer is detrimental to accuracy. However, on consideration, it appeared that the flux in the auxiliary transformer would be very small, and would in fact be equal to the flux in the main transformer reduced in the proportion of the turns on *C* to the turns on *B*, i.e., some 33 times less. The iron section for the auxiliary transformer can therefore be very small, and in fact all that is required is four or five laminations of the same size as for the main transformer.

For those not familiar with the procedure for designing current transformers I would recommend a pamphlet published by the Westinghouse Brake and Signal Co. Ltd., entitled "Rectifiers for Electrical Measuring Instruments," in which a detailed description is given. Messrs. Westinghouse recommend that the tranformer core should be made of mu-metal rather than ordinary iron laminations. I can confirm from experience the importance of this. I made my first transformer with laminations which I happened to have by me, but as a result of excessive iron loss I found that there was far too great a departure from a straight line relationship between input and output currents. A change to mu-metal made a vast improvement, but even so there is a tendency for the meter scale to close up over the first few degrees, principally, I believe, because the rectifiers do not give an entirely straight line characteristic right down to the lowest currents. This is of no great consequence, because it only affects a very small part of the scale at the beginning, and if the meter is calibrated against an accurate standard meter, the closing up of the first few degrees can be allowed for in the scale marking.

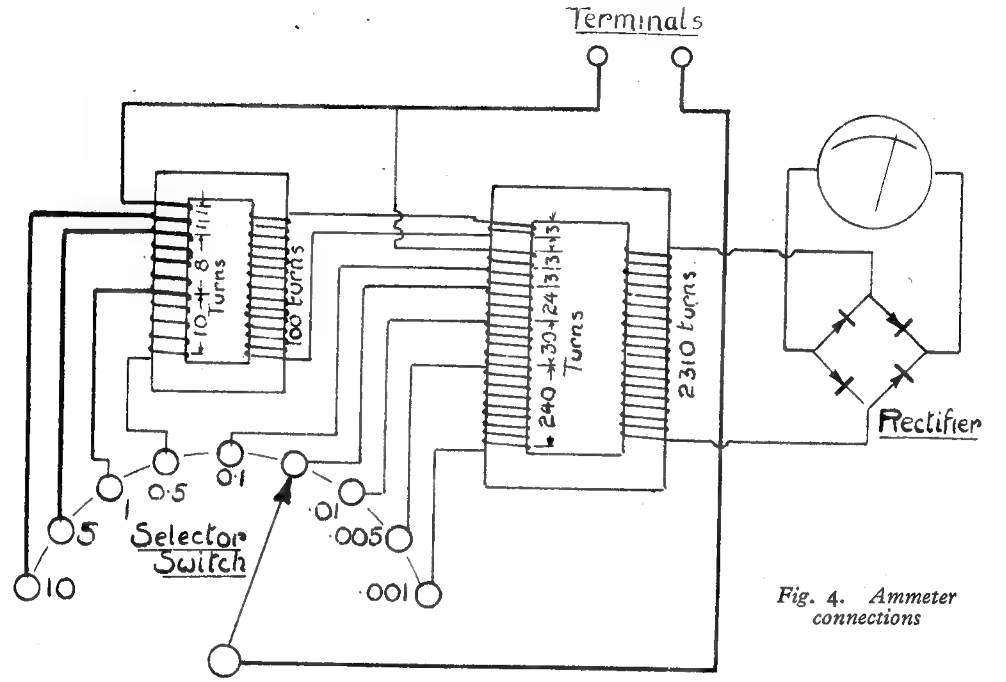
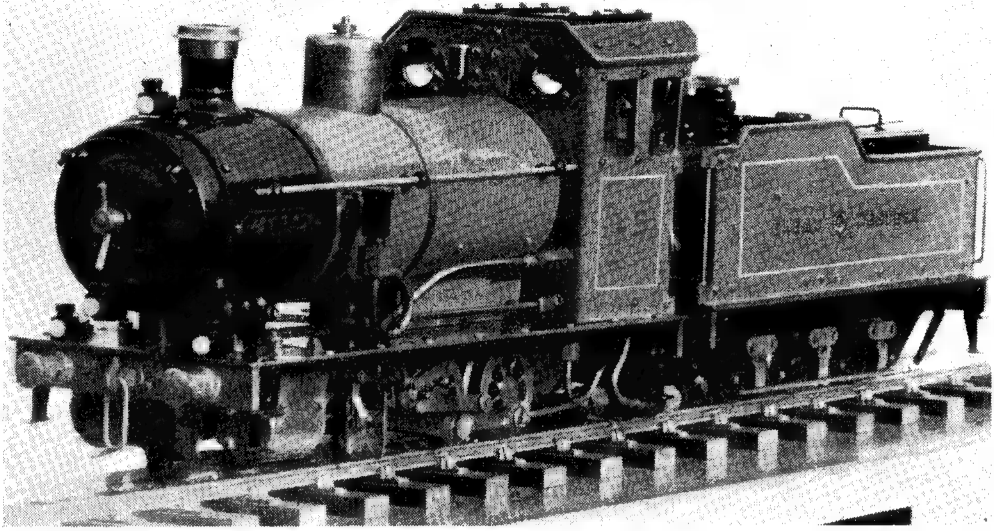



*Fig. 4. Ammeter connections*

Partly because of this slight non-uniformity of scale, and the consequent difficulty of accurate reading at low values, I decided to be somewhat lavish in the number of scale ranges, and have no less than nine, the maximum scale readings being 10, 5, 1, 0.5, 0.1, 0.05, 0.01, 0.05 and 0.001 amp. The large number of scales merely involves additional tappings on the transformer and additional studs on the selector switch, and this small extra trouble is well worth while because of the increased accuracy with which any current over a very wide range can be measured.

The full connections with the transformer windings are shown in Fig. 4, from which it will be seen that on the lower ranges the supply is taken direct to the main transformer and the auxiliary transformer is brought in only for the higher ranges, as a proof of the effectiveness of the auxiliary transformer principle, one single scale is accurate for all ranges, irrespective of whether one or two transformers are in circuit.

# "Felix"—A First Attempt by W.A.



THE photograph shows *Felix*—my first attempt at small locomotive construction. That she has come to be is due entirely to the encouraging and instructive notes of " L.B.S.C." Some years back, this regular contributor put forward a design for a narrow gauge tank locomotive which he named *Miss Therm*; and *Felix* is but my idea of a tender version of the tank locomotive—plus the addition of one or two " Live Steam " gadgets not specified for the tank design.

*Felix* is an 0-6-0 with two cylinders $\frac{7}{16}$ in. bore × $\frac{5}{8}$ in. stroke. Valve-gear is full Walschaerts' with screw reverse-gear instead of a " pole " lever. Coupled wheels are $1\frac{1}{8}$ in. diameter, and all axles are fully sprung. Main frames are 3/32 in. thick.

A mechanical feedwater pump is located immediately behind the front buffer beam; it is driven from an eccentric turned integral with the front axle. Pump dimensions are $\frac{3}{16}$ in. bore × $\frac{5}{16}$ in. stroke. The discharge pipe is taken upwards into the smokebox and, within here, the connections to a feedwater heater, and to the by-pass line, are made. The latter passes to the outside of the boiler through what appears in the photograph as a feed check-valve, but which, in reality, is a simple through-way fitting; thence the pipe runs direct to the by-pass-valve which is on the footplate.

Also on the footplate is a $2\frac{1}{2}$-in. gauge size mechanical lubricator. The drive to this is taken from a return-crank on the right-hand side of the rear axle, and cannot be seen in the photograph—which shows the left-hand side of the locomotive. Oil is delivered direct into the steam-chests through a tee-piece fitting, so that, at the cylinders, there are three tee connections—steam, exhaust and oil.

The boiler follows " L.B.S.C.'s " latest water-tube practice and features a wet back and straight tubes inclined upwards towards the front end. The tubes can, if necessary, be cleaned internally through cleaning plugs on the backhead. The boiler casing is $2\frac{1}{4}$ in. diameter; the inner barrel $1\frac{5}{8}$ in. diameter; tubes are three in number and $\frac{3}{16}$ in. in diameter. Working pressure is 60 lb. per sq. in. and, in addition to the essential range of fittings, a water-gauge, pressure-gauge and working whistle are provided—the latter is slung under the right-hand running board and again, therefore, it cannot be seen. However, the dummy whistle on top of the boiler *is* very prominently in view. The safety-valve is in the dome. The cab sides and front sheets have Perspex windows.

The tender is a plain six-wheeler, with solid wheels $\frac{7}{8}$ in. diameter mounted on sprung axles. It is arranged to carry water and fuel. On the water side, an emergency hand-pump is provided, the delivery from which is taken alongside the boiler to a point diametrically opposite the through-way fitting on the by-pass line, and at which point it connects into the feedwater heater—which is thus common to both the hand and mechanical pump. The heater is inside the boiler casing.

Fuel is carried in a separate pressure-tank and

(*Continued on page* 406)

# PETROL ENGINE TOPICS

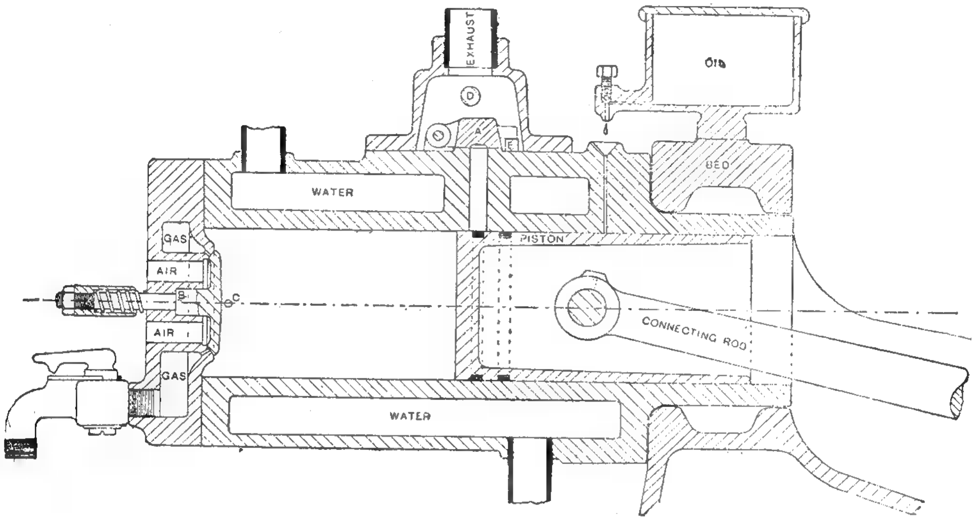
## *More about Unusual Engines

### by Edgar T. Westbury

MANY of the readers who discuss with me what they believe to be new and original ideas for engine design are surprised to learn that in most cases they are simply going over ground which has been more or less exhaustively explored many years ago. Indeed, it might be said that practically every ingenious idea possible in i.c. engine design was exploited in some form or other by the early pioneers in this field of research.

Basic principles in engineering change very little in the course of many years, but progress is attained by a gradual evolution, as a result of practical experience and development. The four-stroke cycle, expounded by Beau de Rochas and practically demonstrated by Otto over three-quarters of a century ago, is still the basic principle on which nearly all the automobile and aircraft engines of the world are designed; while in the simpler two-stroke engine, design is based on the pioneer inventions of Dugald Clerk and Day, which came only very slightly later. Every modern carburettor is a direct descendant of the "inspirator" by Butler (patented in 1889) and the float-feed mixing device of Maybach (1893). Incidentally, the first of these was apparently years ahead of its time, for it embodied such "modern" features as a suction-controlled variable choke tube and an annular diffuser, in addition to float feed. In ignition devices, electric spark ignition was the earliest practical method, as it was used in the Lenoir engine, which pre-dated the Otto cycle.

Even the i.c. turbine, generally regarded as the most modern of all engines, is by no means new, either in conception or experimental practice; its development has only been held back by the limitations of ways and means, mostly in the metallurgical field. The classic example of pioneer research in this type of engine is the Holzwarth gas turbine which ran for several years in Germany prior to the first world war; and it may be of interest to many readers to observe that a design for an i.c. turbine, having all the salient features of the modern "open cycle" gas turbine, appeared in the "M.E." as early as 1905.



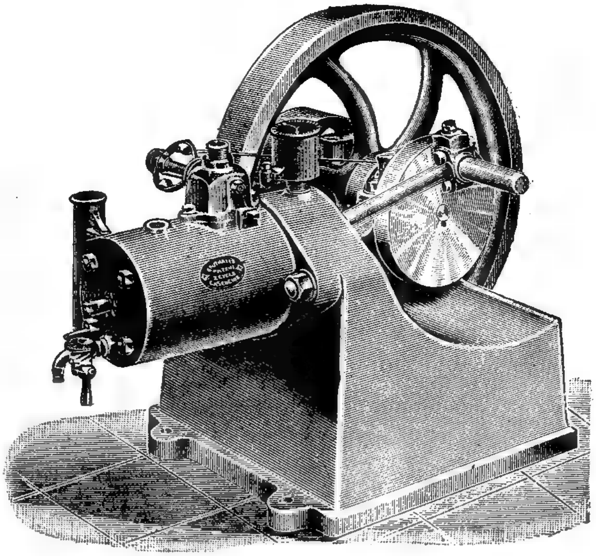

*Section through cylinder of "Ideal" gas engine*

There are, perhaps, many readers who see little point in raking up ancient history, when there is such an urgent demand for getting on with something new. But while one certainly must not live in the past, it is equally futile to neglect the fact that the progress of the future is inevitably based on the deep foundations of the past, and its lessons, not only of success but also of failure, help to shape the things to come.

I was reminded of this a few days ago when visiting a famous research establishment, one of the largest of its kind in the world, and saw some remarkable engines of all types and sizes, many of which were designed simply and solely

**Continued from page 310, "M.E.," March 9, 1950.*

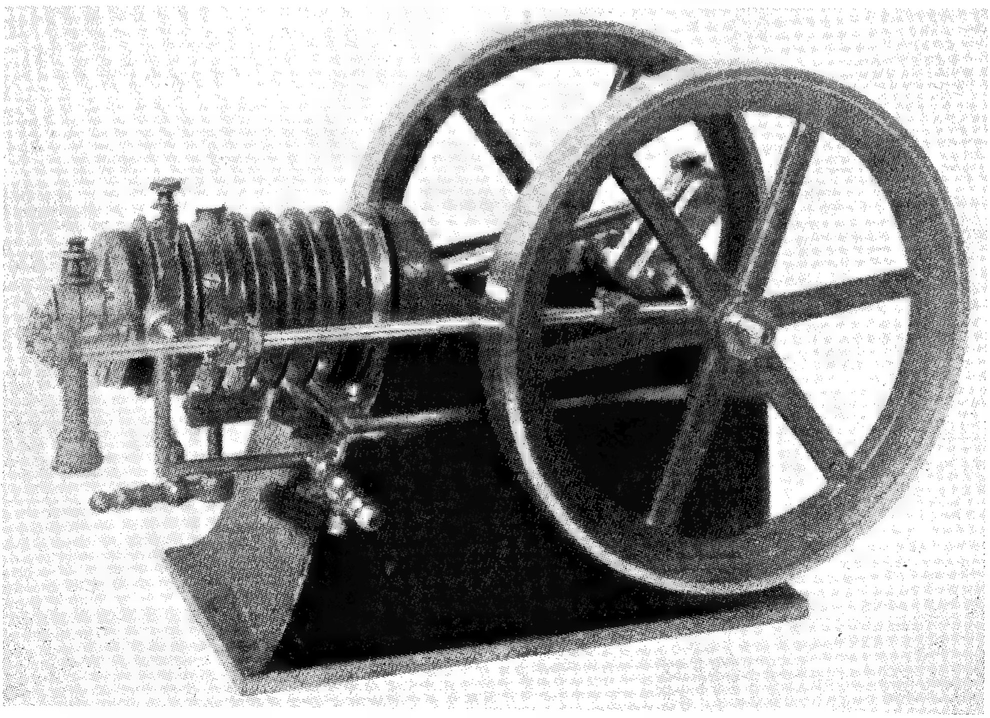
for testing and experimental purposes. Despite the fact that these engines embody the latest thought and development, the roots of their design lie deep in the past, and in more than one case very old ideas, temporarily shelved in the rush of commercial development, have been revived and brought up to date. Of the details of these engines, I am not at present permitted to speak, but I may observe that they included many features of interest to model engineers, and in some instances, well within the scope of their constructional facilities, both in respect of size and simplicity of structure.



*Messrs. Hardy & Padmore's "Ideal" gas engine*
(circa 1890)

## Atmospheric Gas Engines

More than one correspondent has referred to the early flame-ignition "atmospheric" gas engines which were manufactured on the Continent over half a century ago, and were once a prominent feature of model shop windows, where they often occupied a position of honour, resplendent in red and black enamel, sometimes with the addition of gilt decoration as well. These small engines worked on



*A model gas engine of the "atmospheric" type, rebuilt by Mr. D. H. Chaddock*

a very old principle, having [redacted] two-stroke cycle and no pre-compression of the mixture. The exhaust valve was operated mechanically, usually from a bevel-geared side shaft running at crankshaft speed, and was kept open throughout the full length of the inward stroke. An igniter flame was furnished by [redacted] small external gas jet opposite [redacted] "touch hole" or small port about half-way along the cylinder. On the outward stroke, a partial vacuum was formed in the cylinder, causing the automatic inlet valve to open and admit a mixture of gas and air. At somewhere about half-stroke, the ignition port was uncovered, and the flame drawn into the cylinder, igniting the mixture, the expansion of which provided the power impulse for what remained of the working stroke.

These little engines could be made to run at very high speed, and produced plenty of noise if not [redacted] great deal of power. Their volumetric efficiency was low, [redacted] only [redacted] part of the inlet and power stroke was effective for its respective function, and economy was also poor through the absence of compression and also wastage of pressure from the ignition port. Attempts were sometimes made to avoid the latter source of loss by arranging [redacted] slide or other form of valve to close the port after ignition; but generally speaking, the limitations of the working principle made elaboration hardly worth while.

A photograph of [redacted] typical example, rebuilt and put in running order by Mr. D. H. Chaddock, appeared in the issue of THE MODEL ENGINEER dated September 14th, 1939, and I have taken the liberty of reproducing it here for the benefit of interested readers.

### Early [redacted] Ideals [redacted]

One of my correspondents has apparently confused these engines with the "Ideal" engine produced in several sizes by Messrs. Hardy & Padmore, of Worcester, about sixty or seventy years ago. I am not sure whether this firm ever made atmospheric engines, but the particular type known as "Ideal" worked on [redacted] patented principle, which appears to be unique. Again the two-stroke cycle was employed, but provision was made for compression of the charge, and the first half of the outward stroke produced the power, exhaust taking place for a short period just after half-stroke, and the remainder of the stroke was used to draw in the fresh charge. Ignition was produced by means of [redacted] heated tube.

From the sectional drawing of the cylinder it will be seen that the automatic inlet valve controlled both the gas and air supply, and that the exhaust port is uncovered by the piston, a hinged and weighted flap valve being fitted on the outside of the port, so that after lifting under the effect of initial exhaust pressure, it closes when pressure has been relieved and prevents re-entry of exhaust gas to the cylinder. Further progress of the piston causes a partial vacuum and opens the inlet valve to admit [redacted] fresh charge. On the return stroke, the pressure produced during the period the exhaust port is open is not sufficient to lift the valve; beyond that, the charge is compressed, until just before the inner dead centre it is forced into the hot tube and thereby ignited. Governing is effected on the "hit-and-miss" principle, using a centrifugal governor operating [redacted] trip device which holds the flap valve open, destroying the suction in the cylinder and preventing the inlet valve opening, when the speed is too high.

These engines were successfully employed for many industrial purposes, and appear to have been quite satisfactory in use. While they also suffered from low volumetric efficiency, economy was much better than in atmospheric engines, due to the use of compression, and more effective use of the ignited charge. The size illustrated [redacted] known [redacted] the "1A" and rated at "one man-power" at 800 r.p.m. at [redacted] cost of $\frac{3}{4}$d. per hour for gas (at contemporary prices). Both larger and smaller sizes were made, the former producing 1 h.p., also [redacted] twin engine with cylinder dimensions of the same size as the smallest single. No particulars of actual dimensions, however, are available.

### An Early [redacted] Seal" Engine

Some time ago [redacted] correspondent, referring to my design for the 15-c.c. four-cylinder "Seal" engine, asked me if I remembered the early "Seal" marine engine. Most certainly I do—and a very interesting engine it was, to be sure. To the best of my recollection (which may not be absolutely reliable on points of detail, and I trust that any reader with more exact knowledge will correct me if I go wrong), this engine was made by [redacted] firm at Hammersmith and used extensively in light craft. It was a single-cylinder engine, in which the arrangement was unique for marine purposes, though common enough in the early days for stationary work—namely, an inverted vertical engine, with the crankshaft uppermost and the cylinder below it. Like most early engines, the inlet valve was automatic, and the exhaust valve was operated, like some of the engines which have already been referred to, by an ingenious method which dispensed with the need for timing gears. I have no further data on this engine, which whether by reason of good design or workmanship, appears to have been one of the most successful of its day; if any reader can unearth a drawing of it, I am [redacted] it would be of general interest.

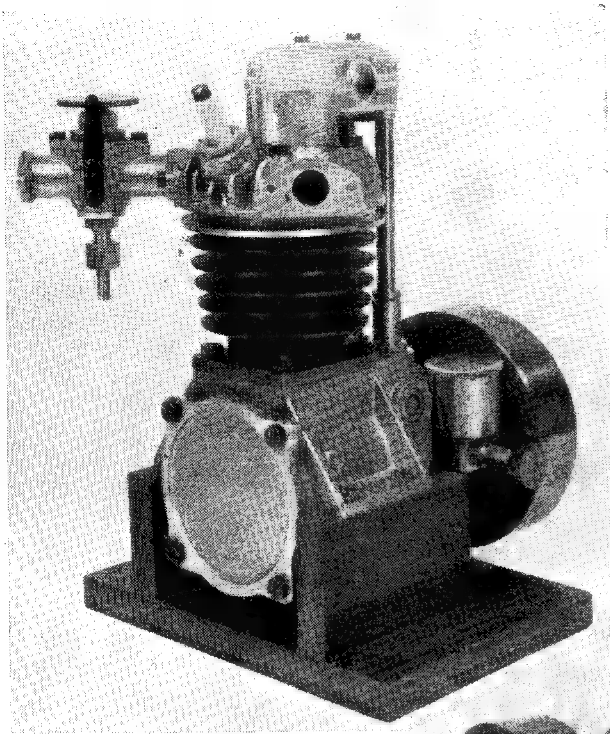
### A New Four-stroke Engine

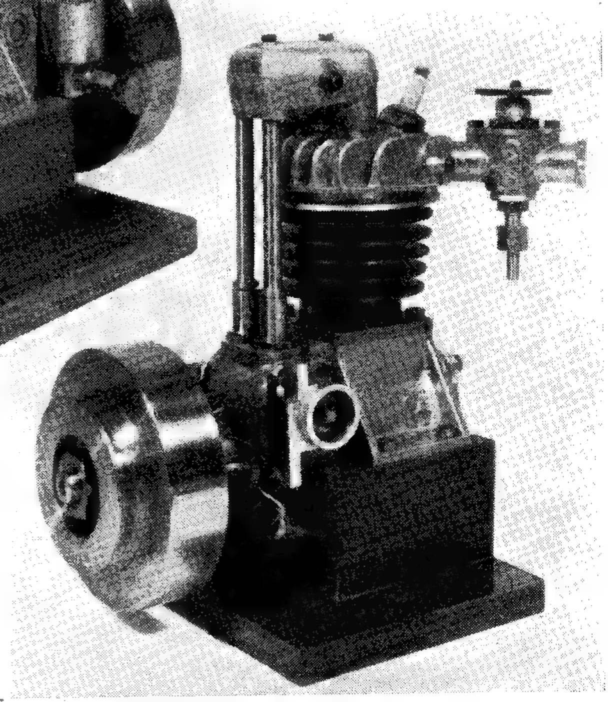
While the adjective "unusual" does not apply in the same sense to the engine now to be described as to the foregoing types, since its working principles and general features of design are common everyday practice in full-size engines, it is nevertheless unique in its particular class, so far [redacted] modern tendencies in miniature i.c. engines are concerned. Since the war, there have been great developments in the commercial production of these engines, particularly those intended to run on special fuels, with glow-plug and compression ignition. To [redacted] great extent, the glamour of these new-found types of engines has overwhelmed and eclipsed the more "ordinary" petrol engine, though few of their exponents would be so bold as to say that the possibilities of the latter are exhausted yet. Moreover, all these engines, without exception, [redacted] of the two-stroke type, and while some of

them have been capable of very high performance, very few of them have presented any specially notable features of design—indeed, some of them are as much alike as two peas.

principles and methods of construction are bound to be the most popular, but this does not entirely excuse the monotony of the present-day commercial product.

The four-stroke type of engine has enjoyed considerable popularity among amateur constructors from the very earliest days of model engineering, and one or two attempts have been made to produce it commercially on a small scale. In the field of high efficiency, particularly in model speed boats, it has never failed to hold its own, and several of the fastest boats in this country are equipped with four-stroke engines. Though it has been neglected and passed by in recent years, I feel sure that there are many model engineers who have a very real enthusiasm for this type of engine, and will welcome





*Two views of the 10-c.c. " C.I. Special " engine, produced by Messrs. J. & G. Jensen Ltd.*

While these developments may be quite satisfying to those who regard the engines purely as a means to an end, and are interested far more in performance than design, they are often somewhat disappointing to those who are engine enthusiasts in the broader sense. As I have so often pointed out, variety is the spice of life in model engineering, as in many other pursuits and pastimes ; without it, interest is liable to dry up and wither in the course of time. One can quite understand that in the commercial production of engines, the very simplest working

with open arms the one solitary representative of its class which is now being produced in quantity, in a popular size for racing models of all types.

This engine made its first public appearance at last year's " M.E." Exhibition, where two complete engines and a set of machined parts were featured as a showcase exhibit, and attracted considerable attention. The engine is produced by Messrs. J. & G. Jensen, Ltd., La Pouquelaye Works, Jersey, and is known as the " C.I. Special "—which I regard as a rather unfortunate choice of title, in view of the innumerable queries

which have cropped up regarding the significance of the initials "C.I." However, the engine, apart from its title, is an outstanding example of miniature mechanical production, and its performance does not belie its external appearance and finish.

I have been associated with the development of this engine since its earliest conception, and am therefore particularly interested to see how the bold experiment of turning it loose in the arena among wild and ferocious two-strokes will pan out. Readers who have followed "Petrol Engine Topics" will no doubt see the influence of some of the engine designs which have been described prior to and during the war, in the various features of this engine. It represents simple and straightforward basic design, adapted to the most efficient and economical methods of production without sacrifice of essential qualities.

The bore of the engine is $\frac{15}{16}$ in. and its stroke is $\frac{7}{8}$ in., the capacity being thus slightly under 10 c.c. It has a diecast crankcase in light alloy, with the housing for the front main bearing, timing gears and camshaft all integral. A blank endplate is attached by four screws to the rear end, replaceable by a special endplate in cases where it is desired to provide a power take-off at this end. The crankshaft is a forging in alloy steel, hardened and ground on the journal surfaces; it runs in a plain bush at the outer end and a ball race at the inner end. Skew gearing is used to drive the camshaft, which is at right-angles to the main shaft, and runs in plain bearings, one of which is formed in the crankcase, and the other in a removable endplate attached to the side of the crankcase by two screws. The cams are copy-formed by milling and form-ground after hardening; they operate on flat-ended hollow tappets and enclosed push-rods.

The cylinder is of centrifugal cast iron, machined all over, and with a square base attached to the crankcase by four studs, the same number being used to secure the head, which is die cast, with inserted bronze valve seatings. A light alloy piston, with two rings, is fitted to the cylinder bore, and the connecting rod is a high-tensile light alloy forging, bronze bushed at the eyes. The valves are vertically disposed in the head, and completely enclosed, together with the rockers and push-rods. Tappet adjustment is effected by quick-action eccentric rocker bushes. Lubrication is provided by gravity, assisted by crankcase suction, a small oil reservoir with a fine adjustment valve being provided on the side of the main bearing, but a larger reservoir with an oil feed pipe may be fitted if required.

A contact-breaker of the spring blade type is fitted to the camshaft housing, and adjustment for advance and retard is provided. The carburettor is a great improvement on the type usually fitted to small engines, being semi-automatic, with a barrel throttle which enables a fuel range of speed control to be obtained. An ingenious device for increasing the jet opening in proportion to throttle opening is incorporated in the control, but does not interfere with independent hand adjustment of the jet. Although normally used without a float, the addition of float feed could easily be arranged.

The engine is normally supplied without a flywheel, as requirements in this respect vary considerably, but this fitting can be supplied to order. It is intended to be attached by means of a tapered collet and draw nut, the shaft extension being plain; a similar method is used for mounting an airscrew hub if this should be required. Normal direction of rotation is anti-clockwise at the flywheel end, but can be reversed without any basic structural alteration of the engine, or the need for any spare parts. Coil ignition is normally fitted, but a built-in magneto is now being developed as an alternative.

The weight of the engine, less flywheel, is 18½ oz., and its power output on the standard compression ratio of 6.5 to 1 on ordinary petrol, is 0.52 h.p. at 10,000 r.p.m., a performance which can obviously be improved upon by increasing compression ratio and using special fuel. Despite the fact that the engine contains three times as many working parts as the usual form of two-stroke, its price is not a great deal higher than the best examples of such engines, while its wide range of utility, flexibility of control, cleanliness, and comparatively quiet running will undoubtedly render it suitable for use in many cases where the habits of the usual high-performance two-stroke are found objectionable. The engines may be obtained completely finished, or in sets of machined or unmachined parts, all separate components being individually obtainable from the manufacturers or their authorised selling agents.

# "Felix"—A First Attempt

(*Continued from page* 401)

the burner is one of "L.B.S.C.'s" vaporising types, but with a single flame-tube inclined upwards to direct the flame over the rear axle and upwards towards the boiler tubes. Fuel used is paraffin.

I have no rail track and *Felix* has not yet run under steam; but under air-pressure she runs very satisfactorily indeed in either forward or reverse gear.

She is painted pea-green with white lines on the tender and cab sides. Running boards and tender frames are of planished material and look very well unpainted. Lettering and numbers are transfers, and after trying to affix these with special preparations, I learned they could be stuck on like postage stamps!!

Leading dimensions are: Rail gauge, 1¼ in.; loading-gauge, 5⅜ in. × 3⅜ in.; overall length, 18¼ in.; so that, for an "O" gauge outfit, she is of impressive size.

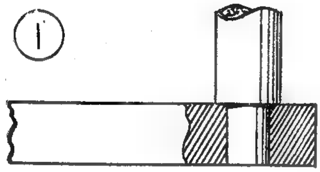
My thanks to "L.B.S.C.'s notes—long may they continue! And thanks, also, to my friend, Mr. Len Farrow, who took the photograph which, as such, I consider deserves praise from all of us.

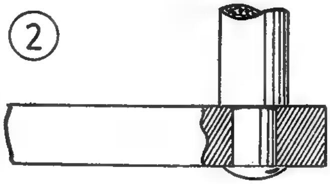
# Novices' Corner

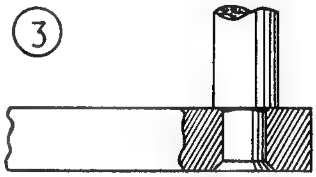
## Fixing Shafts and Pivot Pins

AN operation commonly required in the workshop is to fix a short shaft or pivot in a piece of material for the purpose of carrying a lever or link-rod, or for mounting a pulley or gear wheel. It is proposed, therefore, to describe some of the methods in general use, but to omit those which involve complicated construction or difficult machining.

Where the load is not heavy and removal of the shaft is required only when renewal becomes necessary, the parts can be assembled by using what is termed an interference fit. This means that the shaft is made larger than its housing and is forced into place under pressure. The usual allowance given is to make the shaft approximately one thousandth of an inch larger than its hole for each inch of the diameter; that is to say, a 1-in. shaft will have a diameter of 1 in. plus 1 thousandth when fitted to a hole exactly 1 in. in diameter, and, likewise, a ½-in. shaft will be given a half-thousandth of an inch interference fit. The drawing, No. 1, shows a shaft fitted in this way, but it should be borne in mind that the mating surfaces of both the shaft and the hole need to be smoothly finished; otherwise, when the parts are pressed together, the tops of the ridges remaining after machining will be sheared off and a firm fit will not necessarily result. To enable the shaft to make a true start, its end should be slightly tapered for a short distance by applying a fine file to the work as it rotates in the lathe; in addition, the sharp edge at the mouth of the hole should be removed with a countersink or by using a triangular scraper. If the shaft is oiled before being forced into place, there will be less tendency for the surface of the metal to be sheared and, instead, the parts will slide together more easily and with the maximum of mutual pressure.







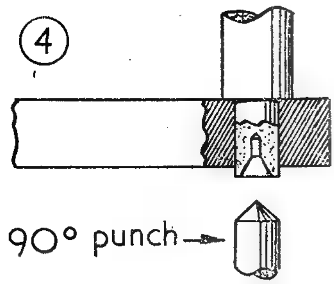
A further danger, when shearing of the metal occurs, is that a collar of surplus metal will be pushed forward and will prevent the shoulder on the shaft seating firmly in contact with the surface of the work. It is advisable to force the shaft into its hole by using screw pressure such as can be obtained with the aid of the ordinary bench vice, for, if an attempt is made to drive the shaft in with a hammer, the blows may not be struck truly and the shaft will then lean to one side, thus preventing the shoulder making proper contact with the work face. As shown in the drawing, No. 2, greater security will be obtained if the protruding end of the shaft is riveted over, for this operation also tends to enlarge the diameter of the shaft and so give it a firmer hold throughout its length where in contact with the hole. Alternatively, the lower surface of the work may be lightly countersunk, as shown in drawing No. 3, and after the riveting has been completed the end of the shaft may be filed flush to give a neat appearance. A method now widely used commercially is that illustrated in drawing No. 4; here, the end of the shaft is drilled with a centre drill and, after the shaft has been pressed into place, the shaft end is expanded by means of a conical punch, which is driven in either by screw pressure exerted in the vice, or by being struck with a hammer.

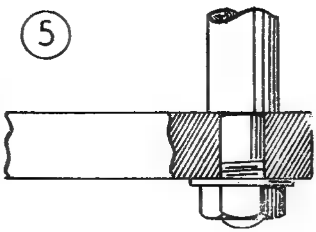
To remove a shaft fitted in the manner depicted in drawing No. 1, either it can be pressed out in the vice, using a short piece of round material as a drift, or it may be driven out with a hammer and punch, but, in the latter event, a firm blow should be struck with a moderately heavy hammer to start the shaft, for a succession of light blows will tend to expand the end of the shaft and render removal increasingly difficult.

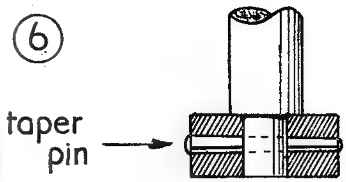
Before attempting to remove a shaft fitted in the way shown in drawing No. 2, the rivet-head must be filed flush. Where, as shown in drawing No. 3, the end of the shaft is expanded into a countersunk hollow, the centre of the head should be punch-marked and a drill is then used to machine away the expanded portion. When the shaft is fitted as shown in drawing No. 4, removal is usually easy, as a drill only slightly less in diameter than the shaft itself is entered for the full distance, and the shell of metal remaining will then cease to grip the housing; moreover, this method of withdrawing the shaft will in no way damage the bore in the work, for the drill will enter centrally and the surface of the housing will not suffer damage from scoring.

To avoid any possibility of the shaft turning after it has been pressed into place, a taper pin may be fitted as shown in drawing No. 6. For this purpose, a hole equal in size to the small-end of the pin is first drilled right through the work; the hole is then enlarged with a standard taper-pin reamer until the pin will go nearly home; finally, the pin is seated either with a light hammer or by applying pressure in the vice.

The method of mounting a shaft illustrated in drawing No. 5 is, perhaps, the one most commonly used where the construction allows room for a nut and washer on the underside. The shaft



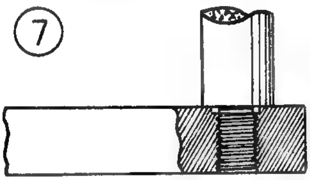



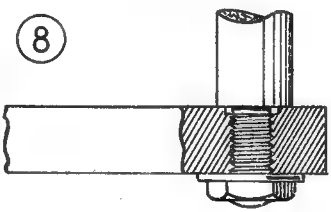

is made [redacted] clearing fit in its hole and, for the sake of appearance, the chamfered or rounded shaft end should project [redacted] short way beyond the nut face. It is important that the shoulder should be squarely formed so as to bed evenly on the work face and, in addition, the point of the turning tool used should be slightly rounded to machine [redacted] small radius at the point where the shoulder meets the reduced portion of the shaft; by this means the shaft is strengthened at a point where fracture is most likely to occur.

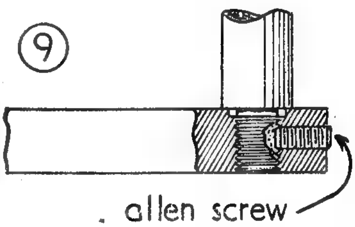
To accommodate the curved surface so formed, the mouth of the hole is made lightly countersunk.

Where the shaft has to be made flush-fitting size prior to tapping, and the neck of the shaft close to the shoulder should be slightly reduced in diameter to clear the thread at the end of the die, and so prevent the formation of burrs in this situation.

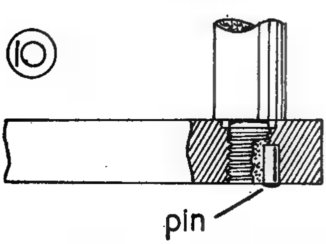
There are several ways in common use of preventing the shaft unscrewing under working conditions. The drawing No. [redacted] shows [redacted] thin lock-nut and washer fitted to the projecting shaft end, but if it is essential that the shaft should be flush-fitting, then, as illustrated in drawing No. 9, an Allen grub-screw can be used to give security. A method sometimes adopted when fitting [redacted] lever or a handle to [redacted] shaft is that illustrated in drawing No. 10. In this case, after the shaft

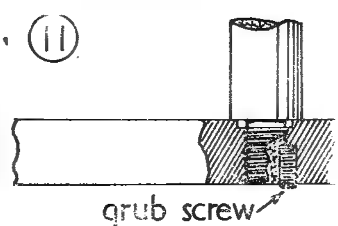


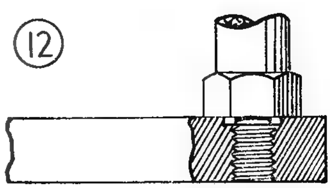




on its under surface, and also to facilitate removal, the parts may be screwed together [redacted] shown in drawing No. 7. Here, it is essential that the screw threads should be accurately cut, or the shaft shoulder will not have [redacted] proper bearing and the rigidity of the assembly may then be greatly reduced. The shaft can be threaded, while still mounted in the lathe chuck, by employing the tailstock die-holder, and great care must be taken when tapping the shaft hole to ensure that the tap is maintained truly upright throughout the operation. For this purpose, the drilling machine may be used in the manner previously described, or a small square can be applied to the tap from time to time where the work is carried out by hand. In addition, the mouth of the hole must be counterdrilled to the clearing has been screwed firmly home, a centre-punch mark is made at the point where the shaft and the hole meet; [redacted] drill hole is then made to a depth of about twice the diameter of the small pin which is then driven into place. Although in this way the shaft is certainly kept from unscrewing, its removal can only be effected by drilling out the pin; this method should, therefore, not be used where dismantling of the parts may become necessary. An alternative method of securing the shaft is to fit [redacted] grub-screw, instead of [redacted] pin, as shown in drawing No. 11; there will then be no difficulty in removing the shaft, but if slackness develops due to wear of the main thread on the shaft, the grub-screw will then have to be refitted in [redacted] new position after the shaft has been screwed home.



If, as represented so far in the drawings, a plain, parallel shaft is fitted, some difficulty may be experienced in screwing it firmly into place owing to the inability to obtain a proper hold.

When the shaft is gripped in the vice for this purpose, care must be taken to avoid damaging the work; copper clams fitted to the vice jaws will afford protection, but if steel filings have become embedded in the clams, these metal particles may mark or score the work surface. It may be found that, even with the vice firmly tightened, the grip obtained is not sufficient to prevent the shaft turning when heavy pressure is exerted in screwing the parts together. The frictional hold can, however, be increased by wrapping a piece of emery cloth round the shaft with the abrasive side of the cloth in contact with the work. Fine-grain emery cloth will serve this purpose best and, moreover, it will not damage the work. As a precaution, the shaft should finally be polished with a strip of worn abrasive cloth in order to remove any emery grains that may have become embedded in the work surface, and which would cause wear of the assembled parts under working conditions. Where the design of the parts allows, a good spanner hold for screwing the shaft into place can be obtained by making the shaft from hexagon material, as illustrated in drawing No. 12. As an alternative mode of construction, the shaft can be turned in like manner from ordinary round bar, and two flats are then filed on the shouldered portion to fit a standard spanner.

# Adjustable Drilling Table and Sine Bar

THIS little tool was made to fit the circular table of my Wolf Jahn milling machine. I made wooden patterns and plaster of paris moulds so as to get as true castings as possible and minimise the machining. The material is a mixture of A1 scrap, and has yielded very nice sound castings.

The single bolt, which is a reamed fit in the body, holds the table at any angle quite firmly, and has never slipped when in use.

By fitting the second plug on a steel plate with an allowance for setting with a micrometer, it makes an excellent sine bar, and enables one to set the table to any angle with accuracy. The screws (two each side) are for levelling purposes.

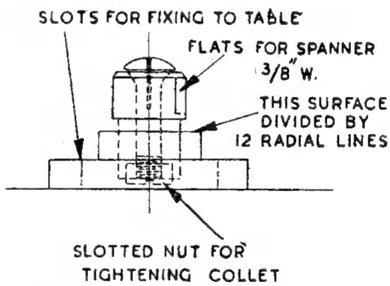
A 5-in. bar would have been better, but was outside the capacity of my tools.

The surfaces were scraped to an accurate surface-plate, and there is no error over 1/1,000 in.

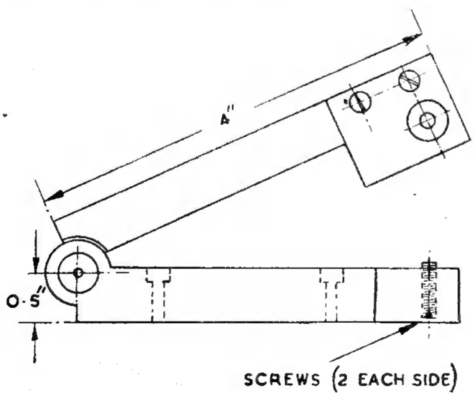
In addition to a small vice which screws on the table, I have made a simple collet holder which takes the collets of my Adams lathe. It is a friction-fit in the base and is divided so that one can mill squares and hexagons.

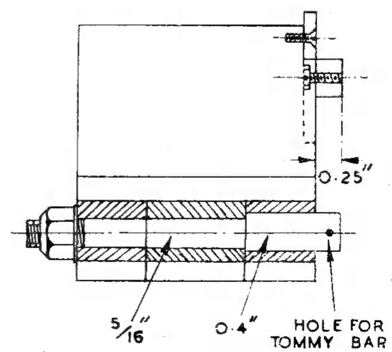
The base is a cast-iron flange I had by me, and the pillar is mild-steel with an inserted key to fit the collet, which is tightened by a short gunmetal screw with a slot for a screwdriver.

H. STOCKER HARRIS.




*The collet fixture*



# Queries and Replies

*Enquiries from readers, either on technical matters directly connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a stamped, addressed envelope, and addressed : " Queries Dept.," THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.*

*Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.*

*More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases, the letters may be published, inviting the assistance of other readers.*

*Where the technical information required involves the services of an outside specialist or consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.*

*Only one general subject can be dealt with in a single query ; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.*

**No. 9780.—Heat-insulating Materials**
**J.F.M. (Colwyn Bay)**

**Q.**—I should like to make an " ice-box," i.e. one box inside another with the space between the walls lined with insulating material. Could you tell me where I could obtain information as to the merits of various materials used for insulating, also possible means of getting down the internal temperature, such as a block of ice?

**R.**—There are quite a number of different kinds of heat-insulating materials, and there is not a great deal to choose between their efficiencies, if they are properly arranged and are not allowed to become damp.

In the case of ice-boxes and refrigerators, such materials as granulated cork, slag wool, felt and kapok are used.

With regard to the cooling medium used in an ice-box, block ice can be used, if provision is made for draining the box ; for obtaining temperatures below freezing point, the ice may be broken up and mixed with salt, but in this case drainage is still more important.

For very low temperatures, and the cleanest working, solid carbon dioxide is the most efficient, and as this does not melt into liquid form, it renders drainage of the box unnecessary.

**No. 9778.—Atom V-driven Lawn Mower**
**D.G. (Edinburgh)**

**Q.**—I propose to mount the Atom V 30-c.c. petrol engine I am building on a hand-propelled lawn mower to operate the cutting cylinder which is 12 in. long and has eight blades (ball-bearing). At present the cylinder is driven by chain from the hand rollers and I propose to mount the engine above these rollers and use the shaft of the hand rollers as a countershaft with a chain drive giving a 5-1 reduction and a further chain drive with a reduction of 2-1 from the shaft of the hand rollers to the cutting cylinder. As the hand rollers have a ratchet mechanism, the proposed set-up will not propel the lawn mower, which will be pushed in the normal manner. Having, I hope, made my purpose clear, there are two points on which I would like your advice regarding the engine :

(1) The drawing I have shows a 26 t.p.i. worm driving the oil pump. Will this worm fit the 20-tooth pinion shown in the drawing on page 164 of *Model Petrol Engines*?

(2) As I intend to use the engine to drive the cutting cylinder of a 12 in. lawn mower, would it be advisable to reduce the compression ratio by machining the top of the cylinder $\frac{1}{16}$ in. longer than shown in the drawing?

**R.**—The Atom 30-c.c. petrol engine will certainly need to have the compression ratio reduced for driving a lawn mower as suggested, and we are of the opinion that the extra $\frac{1}{16}$ in. clearance which you suggest will be insufficient to produce the required reduction.

We would suggest that, instead of making the cast-iron cylinder longer, the cylinder-head should be made with an extension, as this would enable adjustment of compression ratio to be made more readily, should it be found desirable.

We suggest that not less than $\frac{1}{8}$ in. extra clearance in the cylinder-head should be allowed.

With reference to the oil pump for this engine, this pump is intended to have a pinion of $\frac{5}{16}$ in. pitch diameter and with 20 teeth in the pinion, the pitch of the worm should be 20 t.p.i. If, however, you do not propose to use the engine for racing purposes, it might be advisable not to fit the pump but to rely on petroil lubrication, which would be quite adequate for moderate power output, using approximately one part of oil in ten parts of petrol.

**No. 9781.—Stud Making**
**G.F. (Calne)**

**Q.**—Having been quite unable to obtain $\frac{1}{8}$ in. studs from any dealer, I should be pleased to know if there is a way to make these in the home workshop.

**R.**—We suggest that it should not be difficult to do this if a lathe is available, by using a tail-stock die-holder, preferably one fitted with a centre stop to limit length of thread and ensure uniformity in this way. After the studs have been screwed at one end, they may be held in a split screwed bush for putting the thread on the other end, again using a limit stop to ensure uniformity in the length of thread.

# PRACTICAL LETTERS

### The Double Slide Valve

DEAR SIR,—I would like to take this opportunity of offering some additional views to those embodied in my article dealing with the above design. I have read the interesting views of Mr. J. A. Bamford and Mr. E. G. Rix, and it would appear to me that both these gentlemen have left out of their calculations and arguments points that have a distinct bearing on the whole question.

Taking first of all the case as presented by Mr. Bamford, I too, find the expression "projected area of the exhaust *cavity*" somewhat misleading, as the size of the cavity in the slide valve itself has no bearing whatsoever on the outside, or presented area of the entire valve. It is a well-known fact that, under a given pressure, a hollow box or a solid block of equal dimensions is subject to the same external pressure in either the static or moving condition—friction being left out of the picture.

We know also that a perfectly fitting and flat slide valve will stick to a flat surface, due to the entire absence of air between them, leaving atmospheric pressure to maintain the contact.

When a film of oil is interposed between the surfaces the valve becomes free once more, because the same external pressure is acting on the edge of the oil film, tending to push it in and along to any presented passage of escape. If my original example of a valve and a portless face is again applied, plus the oil film and the pumped-up pressure, there is still no tendency for the valve to hold more firmly to the port face, nor for the film of oil to be crushed out.

Those who are interested enough to carry out a simple experiment might care to make up a portless valve face and a slide valve, having a closed chest surrounding them, and capable of being pumped up. A tiny plunger should be fitted in the port face, glanded on the outside, and capable of pushing the valve off the main port face. If this unit is pumped up to any desired pressure, it will be found that the effort required to lift the valve will remain constant over any range of pressures, making allowances for the direct pressure reaction on the plunger itself, which will tend to be expelled in piston fashion. This experiment should be carried out with the valve dry and then with a film of oil interposed, noting the completely free reaction in the latter case.

Mr. E. G. Rix presents a formula giving the varying loads for different positions of the valve, which is quite a fair and accurate assessment, except that, once more, the valve cavity is allowed to enter into the scheme of things—a state of affairs with which I completely disagree.

My original statement assumed the valve to be static and in the mid position covering both steam ports and exhaust port, and in this position it would be subject to the maximum pressure.

Assuming that *all* passages were open to atmosphere, then Mr. Rix's formula would be correct when based on port areas, but not valve *cavity* area. *Only the escape areas can be accepted in such a calculation, and a valve cavity, which does not qualify as an escape passage, must be ignored.*

Under actual working conditions, only the exhaust port may be taken as working at nearly zero, or atmospheric pressure, but at least one of the steam passages—especially if the engine is working hard, will present some back pressure which will tend to relieve the load on the valve. Therefore, an engine running light will have a more heavily loaded valve than the engine working hard in full gear which, in a way, is a comforting thought.

Therefore, taking Mr. Rix's figures and area basis for the ports, and assuming the steam pressure to be 100 lb. and the steam *cylinder* pressure to be 70 lb. at 100 per cent. cut-off (for convenience only) then the formula should read: $(1 + 2 + 1) \times 100$ lb. per sq. in. in the static case and with the valve in mid-position, and: $(1 + 2 + 1) \times 100$ lb. per sq. in. minus 30 lb. $\times$ the area of the working passage left uncovered by the valve.

In other words, the difference between the two pressures will tend to relieve the pressure on a part of the valve still covering a part of the port, whilst a difference in pressure with the port *fully* uncovered, can have no effect on the valve loading at all.

This presents the *approximate* case—a real working formula is a far more formidable problem, and if anyone feels like digging more deeply into the problem and producing even more complications, then I shall disappear—quickly.

Yours faithfully,

Worthing. J. I. AUSTEN-WALTON.

### International Racing

DEAR SIR,—I would like to answer two statements made by Mr. Duffield in his letter published in THE MODEL ENGINEER dated March 2nd.

Mr. Duffield states that, because an American model car racer pushed off his model with a pole 15-20 ft. [!] long, this was an artificial aid to speed. I fail to see this, for surely in the vast majority of contests, isn't the model timed after it has completed several laps to lean out the mixture, and its owner has timed in?

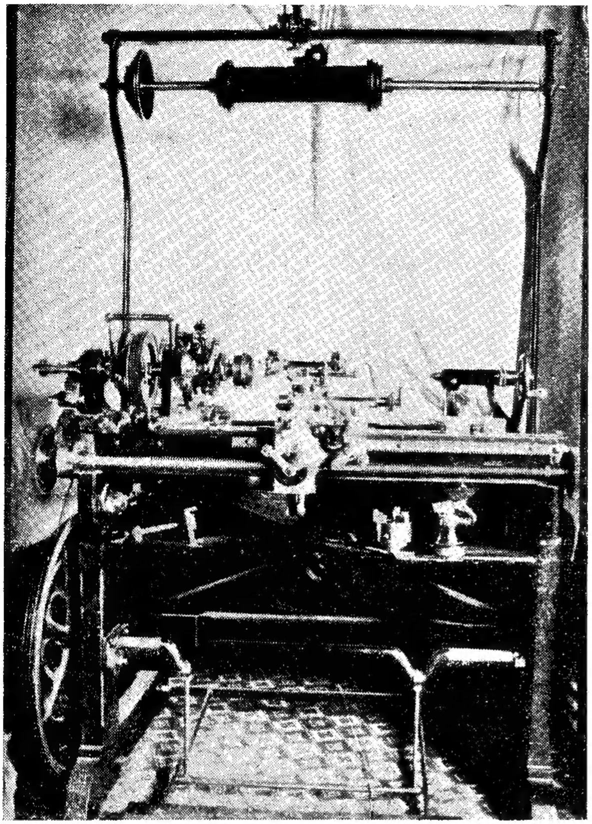
Also, Mr. Duffield says that model car racing in America is dead. All I can say is, have you seen copies of *Rail and Cable News* lately, Mr. Duffield? True, the Yanks are only interested in speed; but if model car racing in the States is a corpse it seems to me that it still has a few kicks left in it!

Yours faithfully,

South Woodford. L. A. MANWARING.
Edmonton Model Car Club.

### Portable Steam Engines

DEAR SIR,—I came across three portable steam engines driving a saw mill recently; they are as follow:—One built by Messrs. Edward Humphries Ltd., Pershore. 6 h.p. single-cylinder high pressure, fitted with a new boiler in 1933, and two 5 ft. diameter flywheels. One Marshall, No. 6490, 1910. 6 h.p. high pressure single-cylinder engine No. 62147, with two 5 ft. fly-



*Photograph No.* 1. *Showing Goyen's lathe and overhead gear*

wheels, this also being fitted with a patent corrugated top firebox. One Clayton & Shuttleworth 10 h.p. high-pressure fitted with two flywheels, but there does not appear to be any makers' number or date.

These engines have been working in their present position for some years, day in and day out, and they are to be replaced by electric motors due to the high cost of fuel, as they require large coal. They will be for sale later in the year.

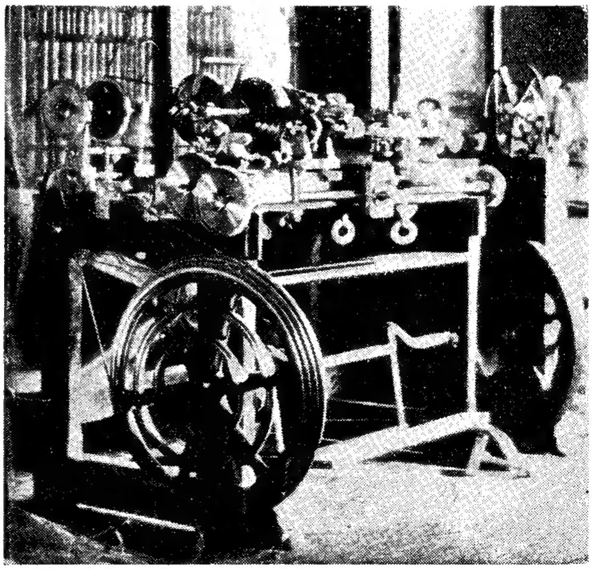
Yours faithfully,
Stourbridge. R. S. MANTLE.

## A Very Old Amateur-Built Lathe

DEAR SIR,—the photographs submitted are copies of very old ones of an amateur-made lathe, which may interest readers. The originals are the property of Mr. John A. Pickles, of Barnoldswick, a gentleman well known to regular readers of THE MODEL ENGINEER for the number of awards he has received at "M.E." Exhibitions and elsewhere, for horological work. I was recently his guest for a few days, and whilst examining two very fine lathes in his private workshop, and of his own design and make, the subject of early lathes naturally came up. Mr. Pickles duly produced the photographs of the Goyen lathe and kindly loaned them to me for copying. The lathe would seem to be a general-purpose machine, the robust leadscrew and backgear, the set-over tailstock, and the deep bed, pointing to a desire for metal turning, while the long slide-rest, the geometric chuck, the tangent wheel and the overhead gear all point to ornamental work, as do also the massive wooden standards. These latter were much in vogue for ornamental turning lathes at the time when this machine was built, and it was said that they absorbed vibration better than metal. They were often of mahogany, and in French lathes were fine pieces of cabinet work. Even when metal beds became common, it was not unusual to find a slat of polished mahogany bolted to the front of the bed, possibly for the same reason. The drive of the Goyen is somewhat out of the ordinary, as can be seen in Photograph No. 2.

Whether Goyen made more than one of these lathes I cannot say, but a short while ago I had a letter from a gentleman who said he had seen one in Edinburgh, and that the workmanship was superb. This, I think, is also proved by the reflection of light on the change-wheels as shown in Photograph No. 2.

Yours faithfully,
Luton. ERNEST W. FRASER.



*Photograph No.* 2. *Goyen's lathe made at Newton Abbot, Devon, about* 1860-70